Design Engineering

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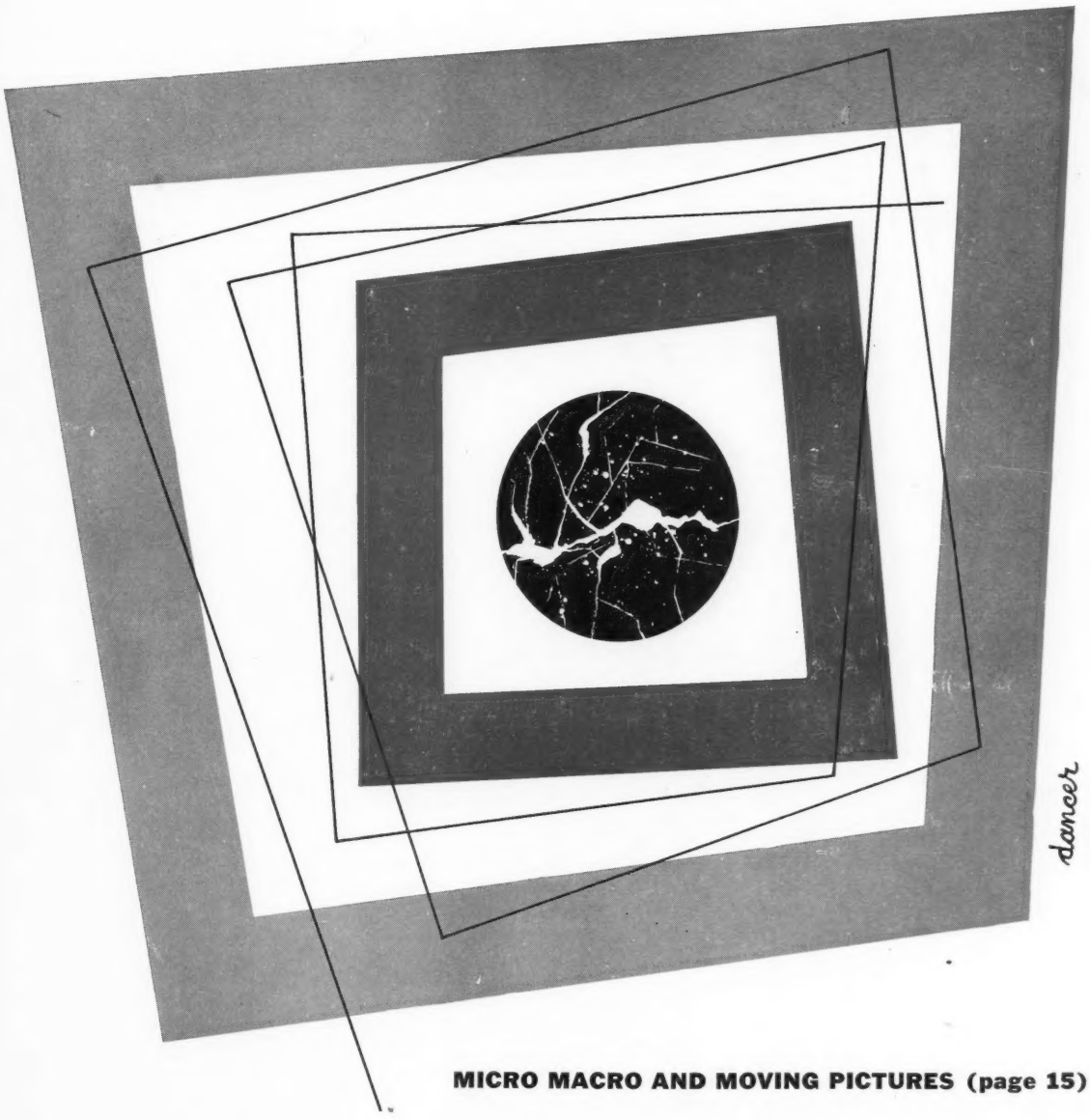
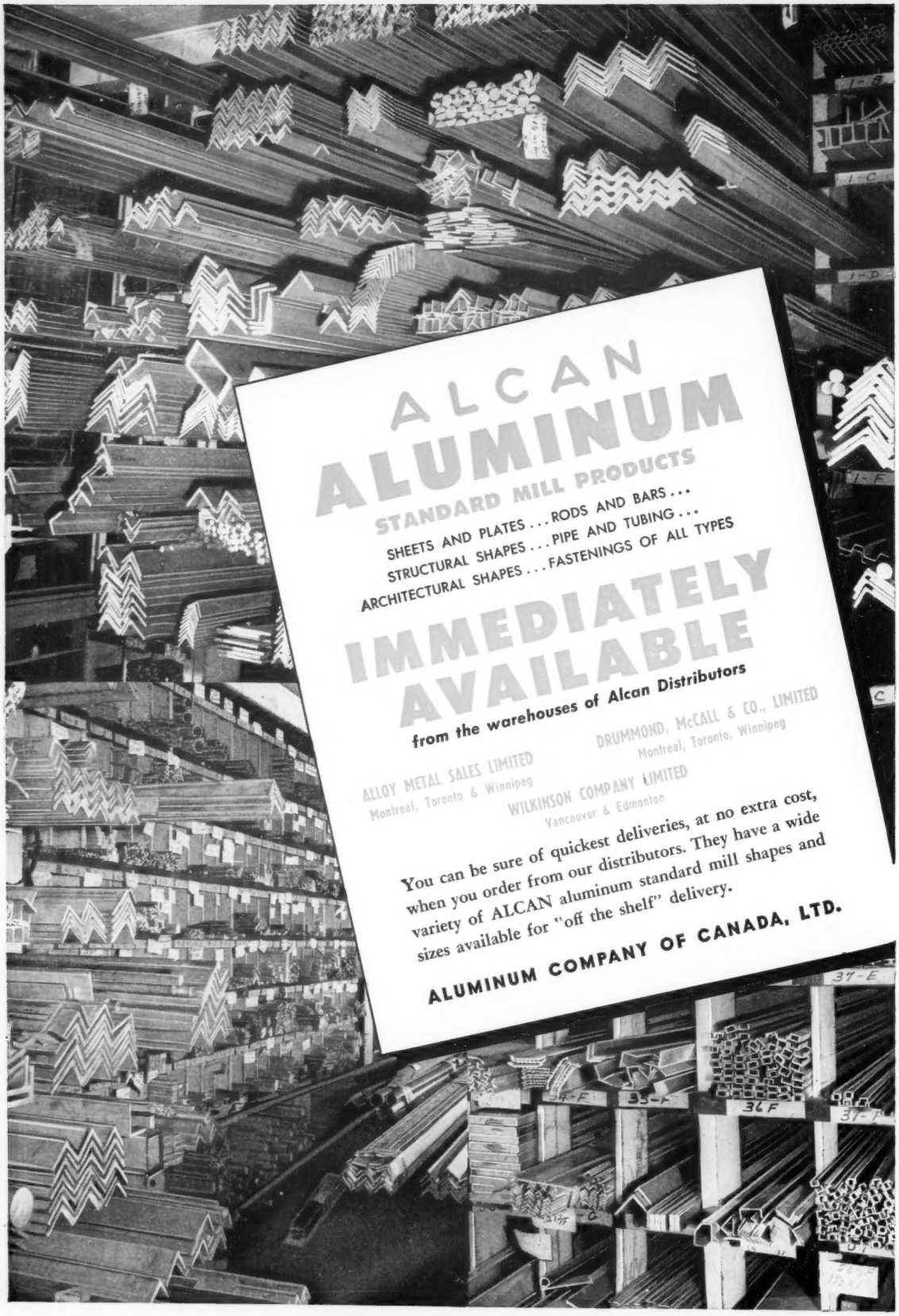


MICRO MACRO AND MOVING PICTURES **(page 15)**

July 1955

Movies come to the help of industry
Use silicone finishes for durability
Cast steel can be better than forged

PUBLISHED BY MACLEAN-HUNTER PUBLISHING COMPANY, LIMITED, TORONTO, CANADA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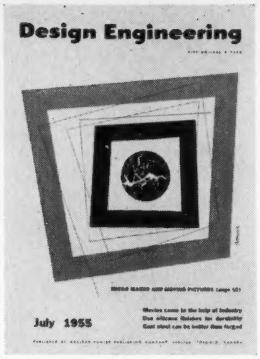

Design Engineering

VOLUME 1 **JULY, 1955** NUMBER 4

This month's cover

Perhaps because last month's cover was less abstract than usual, cover artist Don Dancer has gone all the way with artistic freedom for July. Most readers will see the symbolism. Looking through a squarish camera from behind, the viewer faces a photo micrograph with a magnification of about 300. The cover supports the lead feature on industrial photography — starting on page 15.

Design Engineering

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AERONAUTICAL or CIVIL ENGINEERS for AIRCRAFT STRUCTURAL ANALYSIS.
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Editorial correspondents in: The United Kingdom, the United States, Germany, France and Italy.

The August issue of **Design Engineering** will carry strong feature articles written by contributors no less experienced than those featured this month.

Wire resistance strain gauges will be the biggest feature. These gauges for measuring static and dynamic strain, have important work to do for you.

Steam engines which can be linked by a new method for more power will be described by our German correspondent.

Engineering presentation, some new suggestions that will interest you, will also be featured.

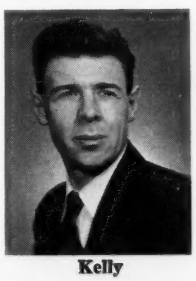
Special Artwork

Editorial layouts designed by art consultant **Desmond English.**

Smallman-Tew

Krane

Giddings



Kelly

ENGLISHMAN AND METALS EXPERT **R. Smallman-Tew** has been chief metallurgist, with Avro Aircraft since the beginning of 1947. Before that he was chief metallurgist with Airspeed Limited (a British company) for eight years and before that he spent 10 years as a metallurgy researcher. There are few technical experts anywhere in the world with longer consistent experience of this specialty study. He discusses steel castings on page 30.

• • •

MODERN FINISHING METHODS, using silicones, are reviewed by **W. C. Krane,** sales engineer to Dow Corning, on page 24. His work consists mostly of giving technical service to customers with finish problems. He is a University of Toronto B.A.Sc., and a registered engineer.

• • •

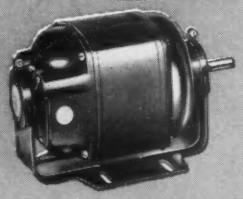
SOME OBSERVANT READERS have commented on the high standards set by DESIGN ENGINEERING's engineering drawing. The man who does them is **Alec Giddings,** an artist from England who has lived in Canada for 13 months. Before coming to Canada, he spent five years in specialized advertising agencies combining art with mechanical understanding. Although a competent "pure" artist, this is the work he likes best. "I like making mechanical stuff pretty," is how he puts it. If readers saw some of the originals that pass through his hands for face-lifting, they might be surprised at the end product shown in the magazine.

• • •

THE FEATURE on magnetic amplifiers (page 34) comes from Dubliner **D. A. G. Kelly,** instructor in electrical technology at Ryerson Institute, Toronto. In 1949 he was electrical plant engineer to the British Aluminum company which closed down that year in the face of keen Canadian competition. "So," says D. A. G. Kelly, "I decided to emigrate to the country which had put me out of a job." He spent a year with the Ontario Hydro before moving to Ryerson. He is a graduate of Queen's University, Belfast.

THERE IS A *Leland* ELECTRIC MOTOR FOR EVERY PURPOSE!

FOR THE HOME ...



Leland Split Phase Motors
The ideal motor for furnace fans, home workshops, water pumps and many other applications.

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Completely new design, smaller, lighter, ruggedly compact, incorporating all the proved features of modern engineering technique.

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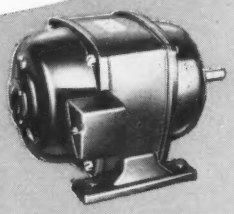
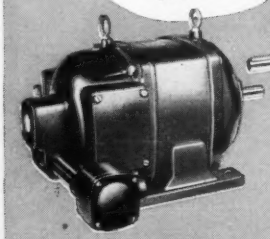
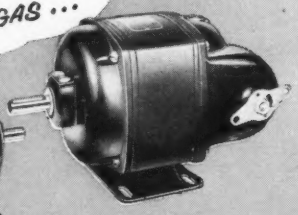


Leland Polyphase Motors
For all industrial applications. Ratings up to 5 HP. Wide range of torques, speeds and mountings.

FOR THE OILFIELDS AND WHERE YOU BUY YOUR GAS ...



Leland Explosion Proof Motors
First to develop explosion proof motors. Today these Leland motors are widely used by Canada's oil and chemical industries.



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"First" again. No matter where you buy your gasoline it is almost a certainty a Leland motor powers the pump.

Motors for household appliances, industrial applications (above or below ground) in inflammable atmospheres or to power instruments of defence . . . whatever your application there's a Leland motor designed for your application.

The special and general purpose motors shown and many other types not illustrated, have made Leland an outstanding example of creative engineering. Our engineers have designed thousands of special motors over the past quarter century, each suited to a specific use. These designs now provide ready answers to many current problems, enabling Leland to furnish special motors with maximum speed and economy.

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Contact your nearest Leland distributor, branch or head office. We welcome the opportunity to serve you.

Sales **COAST-TO-COAST** ***Service***

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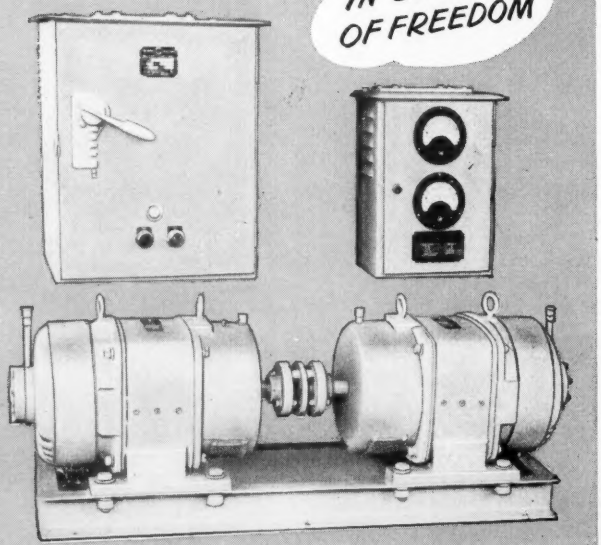


Leland Motor Generator Sets and Controls
DC and 25 to 3000 cycle generators, built to rigid specifications for service on land, sea and airborne defence equipment.

LELAND ELECTRIC CANADA LIMITED GUELPH

Reports

News in brief from the world's producers

BRITISH INDUSTRY'S relief at the **Conservative Party's general election victory,** and the removal of the threat of further disastrous nationalization experiments, has been overshadowed by the mounting crisis in industrial relations.

The socialist threat to Britain's engineering and allied industries, which account for over 40 per cent of the nation's exports, was real enough. A plan existed for taking particular sections of the industry into public ownership, but while industrial leaders have much to be thankful for they cannot blind themselves to the sharpening conflict in the industrial sphere which has resulted in crippling strikes in the coal mines, on the docks and on the railways.

At midnight on the day after the last vote had been counted the nation's transport system was plunged into chaos by the strike for more pay. Seventy thousand railway locomotive men were involved. Then Prime Minister Sir Anthony Eden, in the gravest radio message to the nation since the war, warned of hardship and unemployment on a rapidly increasing scale.

Less than 48 hours after the rail strike began Eden's prophecy began to be fulfilled when the first firings started because of the need to curtail production in the steel industry. The following day the Government announced a state of emergency.

It is against the menacing background of industrial unrest that one has to measure the satisfaction among industrial leaders generally at the news that the lower middle-class, the hard-hit dwellers in suburbia, had turned their faces firmly against renewed socialist experiments.

Sir William Rootes, chairman of the Rootes group and of the Dollar Exports Council, says: "Shipping has already been seriously curtailed by the dock strike and, with the exception of the continent and a few other markets, export activities have largely ceased. There are inevitably bound to be serious repercussions. Production for some time ahead will be disrupted."

Some steel and engineering firms say: "No politics." This kind of caution, developed in recent years from fear of reprisals should the Socialists return to power, lingers on in many quarters. (From our U. K. Correspondent.)

• • •

JUDGES' NAMES and entry conditions for the 1956 design awards have been announced by the **National Industrial Design Council.**

The judges are: J. D. Ferguson, past-president CMA; Prof. E. A. Allcut, University of Toronto; J. S. Luck, ACID, staff designer, Aluminum Laboratories; W. M. Murray, president Canadian Retail Federation; and Mrs. John Butterfield, Canadian Association of Consumers. Besides the judges there will be an advisory committee of qualified people to assist with preliminary rating.

There are a few small changes in the conditions of awards. The most important of these affects last year's winners. The 955 conditions stated that: "Last year's winners are automatically eligible for consideration and . . . will be asked to re-submit for judging . . ." In the 1956 conditions, this clause is deleted.

• • •

A NEW manufacturing plant and sales office in Edmonton has been opened by **Marsh Instrument & Valve Co. (Canada) Ltd.** The resident manager will be Mr. M. C. Minton of Edmonton.

Heading the manufacturing staff will be Mr. Clyde Fisher, a factory trained instrument specialist, also of Edmonton. The new plant, located in the centre of the fast growing Canadian oil industry, is designed and equipped to give prompt and efficient instrument and valve service.

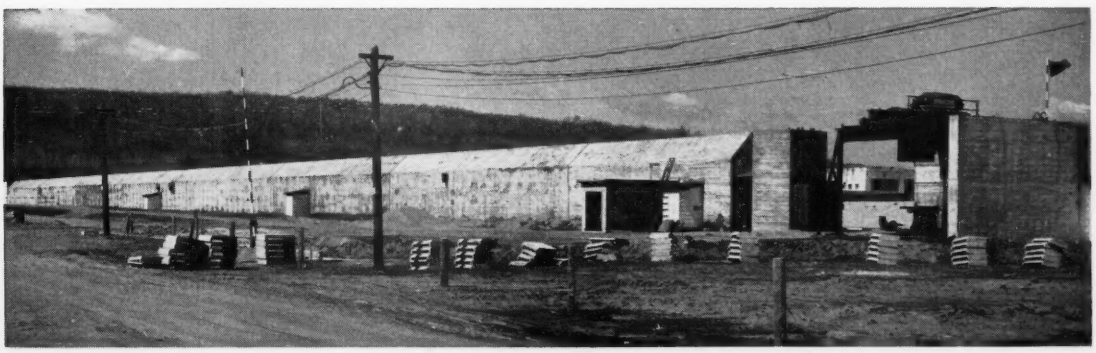
In addition to the indicating gauges and needle valves to be manufactured specifically for the petroleum field, the new plant will produce gauges of all types, regulating valves, industrial thermometers and needle valves for use in all industries.

• • •

THE WOLD'S LARGEST aluminum-wound power transformer is now under construction in the St. Catharines, Ontario plant of the **English Electric Company.** It will play an important part in the expansion now under way of the Kitimat, B.C. smelter of the Aluminum Co. of Canada. The current expansion program, started in October, 1954, will add 60,000 tons to Kitimat's present aluminum production capacity of 91,500 tons a year by the end of 1956. A further expansion now authorized for completion in 1959 will bring the total production capacity to 331,500 tons a year.

The English Electric transformer will transform 70,000 kva from 275 kv to 13.2 kv and is the largest ever built with aluminum windings. The hv winding wire will be insulated with an appropriate number of paper layers; the lv wire will have an extra-heavy Formel coating. The total weight of the aluminum wire will be approximately 11,000 lb.

Alcan already has a number of aluminum-wound transformers in operation in various locations, and all have given completely satisfactory service. They range in size from 220 to 20,000 kva. Aluminum was selected for the winding material of the new 70,000 kva unit so that a study might be made of the design and economics of the material. ★



The first of its kind. Canada has built an experimental indoor range, 750 ft. long to help speed the study of projectiles and aircraft models. Fired at up to 4,000 mph, the objects slash through paper screens, leave holes which reveal performances.

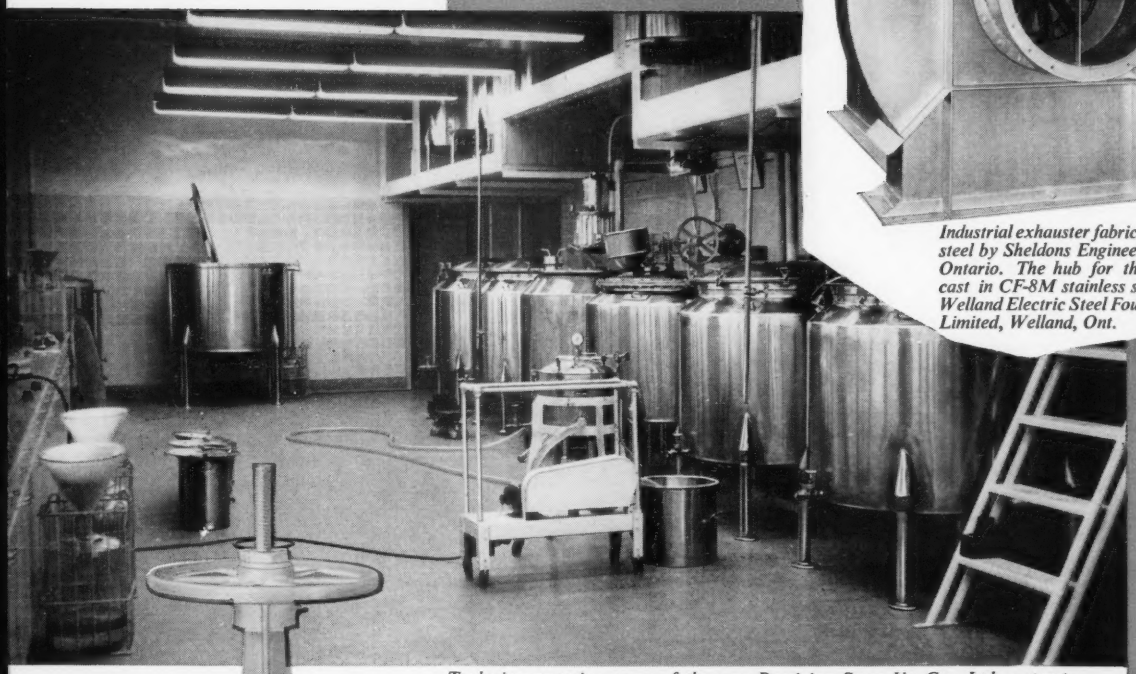
"To the success of your mechanism"
Wallace Barnes SPRINGS
The Wallace Barnes Co. Ltd.
HAMILTON, ONTARIO

YOU CAN DEPEND ON

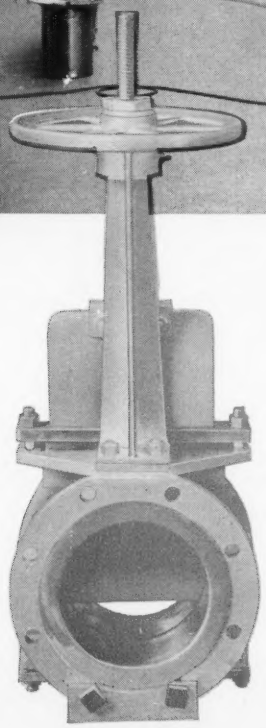
NICKEL-CONTAINING

stainless steel

Industrial exhauster fabricated in stainless steel by Sheldons Engineering Ltd., Galt, Ontario. The hub for the impeller was cast in CF-8M stainless steel by Welland Electric Steel Foundry, Limited, Welland, Ont.



Tanks in processing room of the new Dominion Seven-Up Co., Ltd., extract plant in Toronto, fabricated by Toronto Coppersmithing Co. Ltd. Stainless steel containing nickel is used exclusively throughout.



Type 316 stainless steel valve designed to operate in pulp mills in conjunction with either wood-stave pipe or conventional alloy stock lines . . . fabricated by Ellett Copper & Brass Co., Limited, Vancouver.

LONG-LIFE SERVICE AND PRODUCT PURITY

The excellent corrosion resistance of nickel-containing stainless steel accounts for its wide acceptance in many process industries. Because of its high tensile strength, lightweight equipment can be fabricated which performs dependably under severe conditions. Its ability to withstand corrosive attacks aids in the manufacture of high purity products that are free from harmful discolouration and metallic contamination. Illustrated are a number of applications where chromium-nickel stainless steel is providing outstanding performance.

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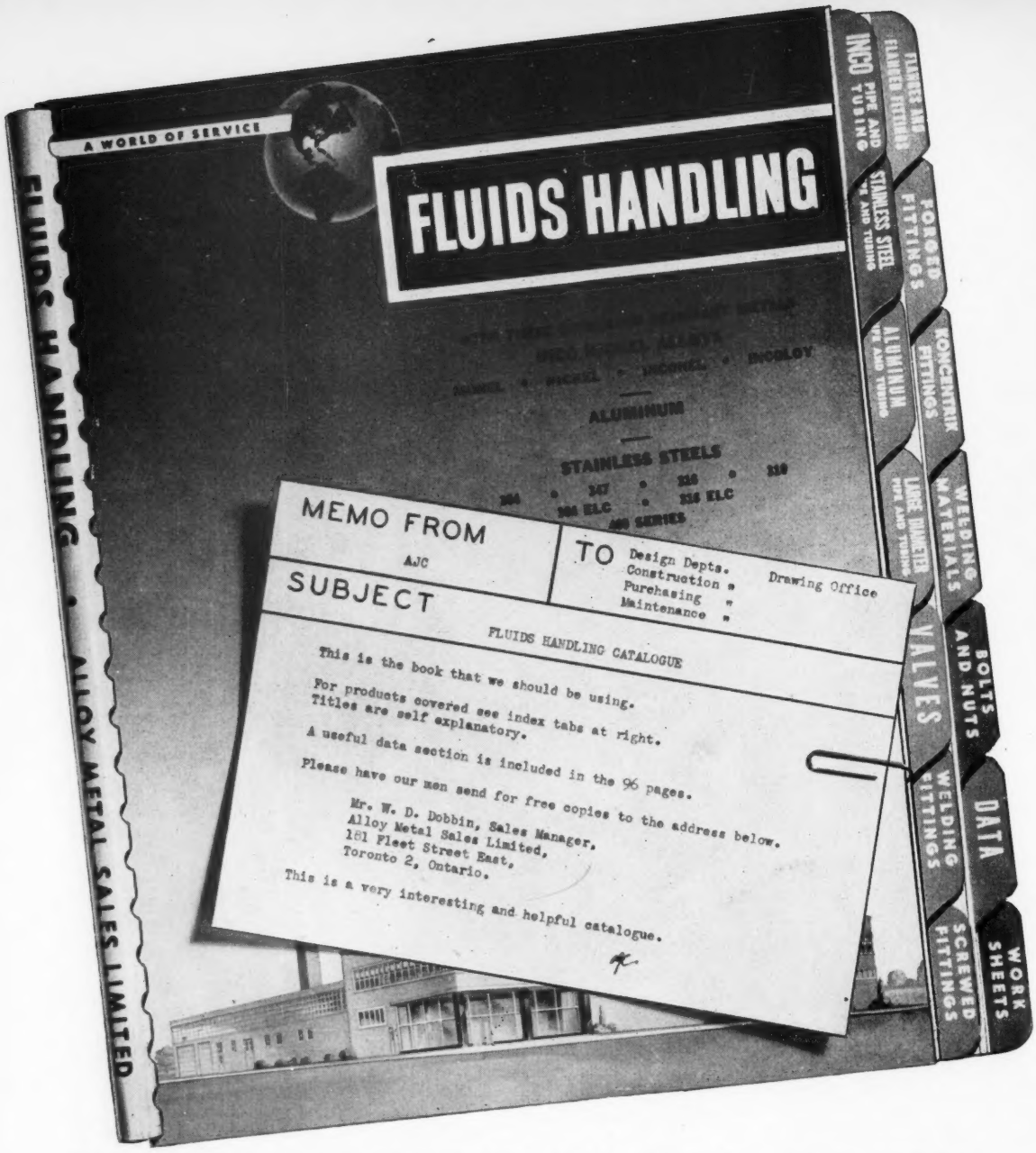

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A new line of units has been added to the Kollsman "Special Purpose Motors" family. It consists of Induction Motors and Induction Generators that are supplied separately or combined in a single case one-inch in diameter. These new motors have been designed to give the maximum torque per watt ratio with the minimum rotor inertia. The generators give maximum output voltage with minimum residual voltage and phase shift.

A particularly interesting feature of Kollsman "Special Purpose Motors" is the interchangeability of parts permitting numerous electrically different combinations of motor and generator windings within the same case.

Principally, Kollsman "Special Purpose Motors" are for operation in 60 or 400 cycle systems. Power output does not exceed 1/100 horsepower. Gear ratios as high as 1:78,000 available.

COMPLETE INFORMATION IS AVAILABLE ON REQUEST AND SPERRY ENGINEERS WILL GLADLY HELP IN ANY PROBLEM INVOLVING THESE MOTORS.

SPERRY *GYROSCOPE COMPANY OF CANADA LTD.*

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Cleveland Speed Variator

NOW available in 9 sizes, ranging from one-half to 10 horsepower at 1750 input RPM.

INFINITELY variable, stepless speeds within a 9:1 range (from ⅓ to 3 times the input speed).

Smooth, instant change of speed by simple manual adjustment or by remote control devices, either manual or power operated.

Operating efficiencies—75% to 90%.

Coaxial input and output shafts, rotating in same direction, either clock-wise or counter clock-wise.

Ample bearing support for both input and output shafts to carry overhung pulleys.

Compact and inherently quiet and smooth running, due to simple construction.

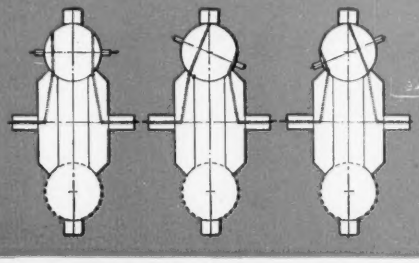
Minimum maintenance and long life, due to absence of belts and other complicated linkage.

Performance proved by prolonged tests in the laboratory and field operation.

These are the outstanding advantages of the Cleveland Speed Variator. It is now ready for service. Immediately applicable to a wide variety of machines and equipment where a dependable variable speed drive is required.

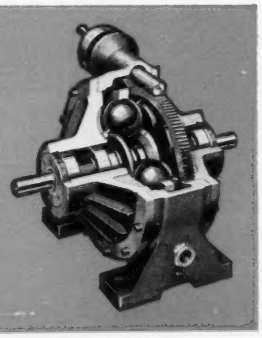
For detailed description and specifications, write for Bulletin K-200, Peacock Brothers Limited, P.O. Box 1040, Montreal, Que.

HOW THE CLEVELAND SPEED VARIATOR WORKS



Power is transmitted from input shaft to output shaft through alloy steel driving balls which are in pressure contact with discs attached to the two shafts.

Relative speeds of the shafts are adjusted by changing the positioning of axles on which the balls rotate (see diagrams, left, and cutaway view, right).



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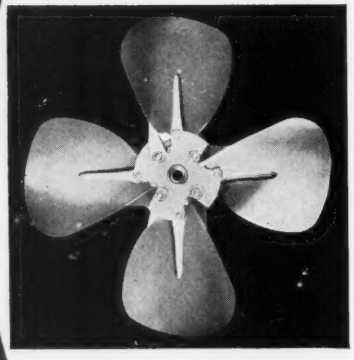
You Can Knock Down Costs

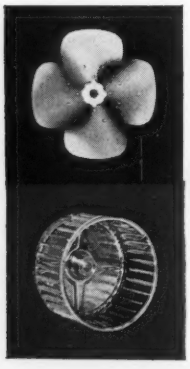
...with this knocked down fan blade

The Torrington "M" Series" master ventilating fan blade gives maximum CFM per horsepower and its quiet operation is a big selling point with customers. Best of all, the special knock-down construction saves you space and freight costs—yet the fan is quickly assembled and requires no special tools. Blades are furnished in matched sets in 24", 30", 36", 42" and 48" diameters.



The "M Series" fan blade represents only a small portion of the unusually broad variety of air impellers which Torrington produces for heating, ventilating, refrigerating and air conditioning equipment. This product range and manufacturing capacity can provide...quickly and at low cost...the fan blade or blower wheel best suited to your air-moving requirements. Torrington has extensive research and test facilities which are available to assist you in the solution of design problems relating to air flow, sound and vibration.

No one has had more experience in the design and production of air impellers than Torrington. Nowhere else can your dollars buy so much in terms of product quality and customer service.



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VIP's

Important people who are in the news

QUICK-GROWING PSC Applied Research Ltd. has made three important staff changes. Production-expert **F. Manly Haines** has been appointed to the board; **Dr. E. O. Braaten** has been made head of the product design department; and de-icing specialist **E. O. Robertson** has been named as senior project engineer.

American (Wyoming) born Manly Haines came as a schoolboy with his family to Canada in 1912 and settled first in Watrous, Saskatchewan. From there he headed further west, in the depression times, as a young man in search of a job. He found one with Consolidated Mining and Smelting who put him on electrical construction and maintenance work. This kept him busy for eight years until he left the world of business to work for the Government in 1942. He stayed in government service for a further eight years, spent most of this time as an inspection officer for radar electrical engineering and electronics. But an urge to go back to business sent him on his way from Ottawa to a Guelph manufacturing company as sales manager in 1950. A year later he joined PSC as production manager.

In private life, Manly Haines has a hobby closely related to his work; he is a radio ham. Before the war he was VE4EU and VE5MQ, now operates as VE3BCW.

Dr. Braaten also started in the West. He was brought up on a Saskatchewan farm and fought his way into the scientific world through hard-won scholarships. He is now an M.Sc. (University of Saskatchewan) and a Ph.D. (University of Toronto). He is one of Canada's top instrumentation experts.

E. O. Robertson is a Cambridge university M.A., an Associate Fellow of the RAeS and of the CAI and an ex-RAF engineering officer. Since 1945 he has been an expert in aircraft icing problems and will now have a new wind tunnel which can create icing conditions to help him take his researches further. PSC Applied Research is installing the tunnel as part of a $50,000 improvement program now under way.

PSC Applied Research (PSC stands for Photographic Survey Corporation) has grown impressively during its four years in business. Since 1951 its staff has grown from 58 to 300, its turnover from $250,000 to $2½ millions, its floor space from 4,000 sq ft to 40,000 sq ft.

The company designs, engineers and manufactures instruments, controls, survey systems and photographic gear. It is doing a great deal of work for the Government which includes navigation computors and de-icing equipment for the CF-100.

The new senior-staff appointments are part of the plan to keep the expansion going at the same dramatic speed.

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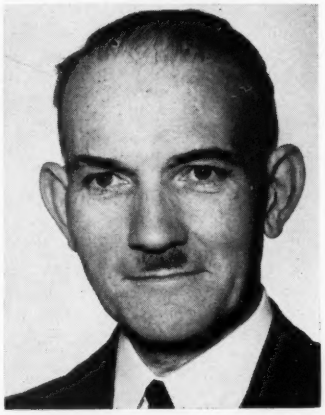
WHEN ORENDA'S vice-president (engineering) and chief engineer **Charles A. Grinyer** returned from a recent trip to Europe, he was asked if anything unusual had happened. He gave the simple



Super-brain Charles Grinyer

answer "no." Later it became known that he had been elected to the super-brains committee known as the Hawker Siddeley group's design council. To most engineers this would be unusual.

The 11-company group found that quicker progress came from pooling knowledge than from guarding it. The design council which consists of about 20 top engineers, is the pool into which the shared knowledge is put at twice-yearly meetings. Members, speaking for their companies, explain what they are doing and where they think they are heading.

Orenda Engines Ltd. is not a member. But Charles Grinyer is qualified to sit through his company's association with A. V. Roe (Canada) Ltd. He is the second Canadian to join this international committee which is said to be the greatest single collection of aeronautical brains in the world.

• • •

AN ENGINEER has been appointed manager of New Products, Linde Air Products Company. He is **F. L. Neuman, P.Eng.**

Neuman will be responsible for the development and sale of new products which at present include Linde Silicones, Linde Flame Plating and Linde Molecular Sieves. Other products will be added from time to time.

Before this appointment he was general superintendent of plants and during the past thirteen years has had wide experience in development and production in the Linde organization. He is a B.Sc. (Metallurgical Engineering) and a member of the Professional Engineers of Ontario.

• • •

AT A RECENT meeting of the Board of Directors **H. George De Young** was appointed Executive Vice-President of Atlas Steels Limited. In announcing this today, R. H. Davis (president) explained that De Young had acted in this capacity for some time.

After joining the Atlas company in 1951 as Works Manager, H. G. De Young was successively named vice-president Operations in May, 1952, and appointed to the Board of Directors in March, 1954. Immediately prior to his first Atlas appointment, he was Works Manager of Treadwell Engineering Company, Easton, Pennsylvania.

Born in Grand Haven, Michigan, he attended the Michigan State University for one year, then received an appointment to the United States Naval Academy at Annapolis, where he graduated in 1931. Thereafter, he resigned his commission in the Navy and went to work for Midvale Company, Philadelphia, an old and well-known firm of tool steel and special alloy steel manufacturers.

He became, successively, supervisor of hammers, assistant superintendent of the shell department making armor for naval vessels, and superintendent of the shell department making armor-piercing projectiles. In the latter job, he received an award from the U. S. Government for research and development. In 1935, he became superintendent of rolling mills and was made works engineer for Midvale in 1947, resigning in 1949 to go to Treadwell Engineering for the two remaining years before he joined Atlas.

The De Young's have two sons and live now in Fonthill, Ontario.

• • •

THE PURCHASE of the building, tools and equipment of Lion Grinding Wheels Ltd., located in Brockville, Ont., is announced by **Donald Weston,** Managing Director of the Simonds Canada Saw Co. Ltd. The plant will be used for making grinding wheel products and will soon start work.★

IT'S WESTINGHOUSE...

NEW Life-Line A

THE WORLD'S BEST MOTOR...FOR YOU

Motor problems cost money. Here is a motor that will run longer and work harder for you than any other motor you have ever had. For instance, the new and exclusive insulating system allows greater sustained overloads.

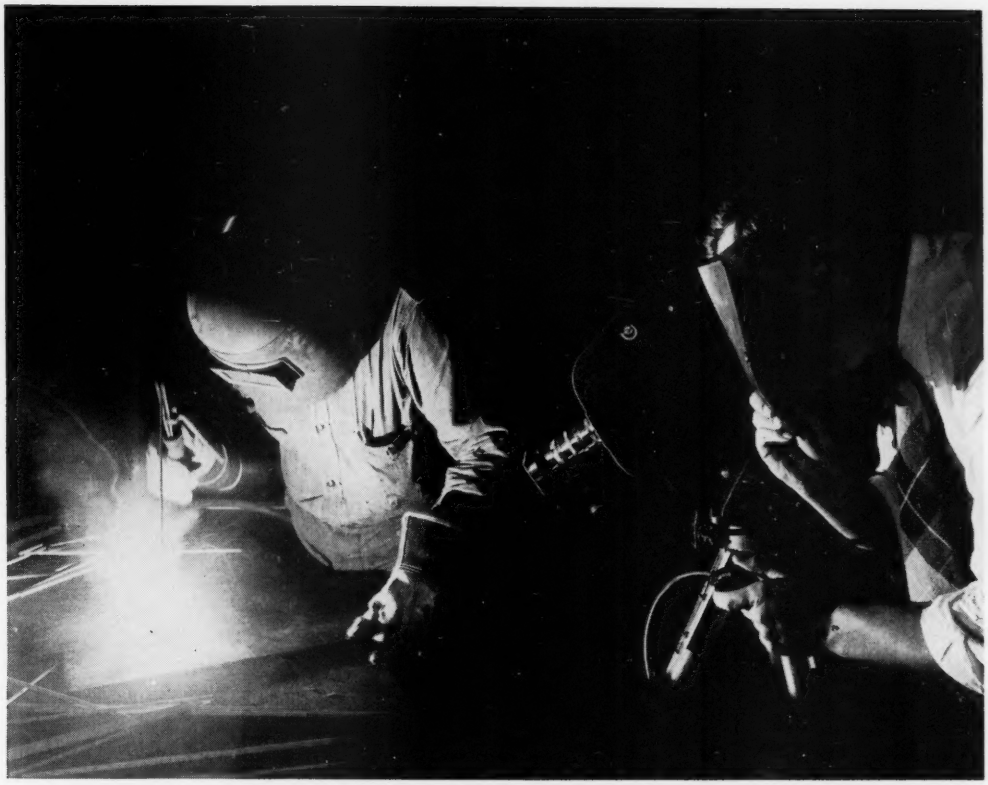
The new Bondar insulating enamel lasts three times longer than conventional enamels.

The new Mylar slot cell insulation is stronger than will ever be needed.

The new Bondite impregnating varnish sheds water and shrugs off corrosive elements.

YOU CAN BE SURE ..IF IT'S Westinghouse

CANADIAN WESTINGHOUSE COMPANY LIMITED, HAMILTON



By recording a difficult weld, later studies can be made of the way it was done if the joint is a failure.

Industry's Wonderful Aid Modern High-Speed Movie Camera

When one-and-a-half seconds can be stretched into four minutes, faster-than-the-eye actions are easily followed. This is how a camera helps modern mechanical testing

HIGH SPEED MOTION PICTURES, can now stretch one and a half seconds normal action into four minutes. Photography has become a wonderful aid in mechanical (and other) testing where the action is faster than the human eye can see. When repeated mechanical checking cannot produce an answer, the high speed movie camera often does.

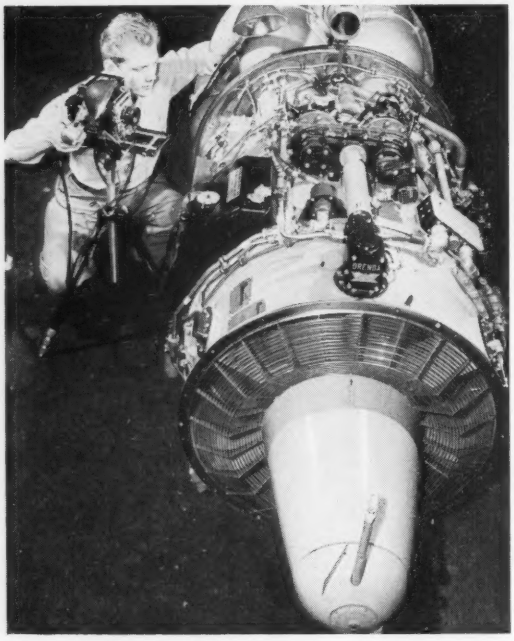
When the processed film is run through a standard projector at sixteen frames a second, action which is only a vague blur to the human eye is seen on the screen slowed down as much as two hundred times, so that it can be readily studied and analyzed.

The pictures made with this high speed camera are notable for their sharpness and clarity and their frame size is large enough to show detail clearly in enlargements made from individual frames.

As an example, a company making metal products

Continued on next 4 pages

Movie Camera *continued*



New Orenda pipe layouts are recorded for assembly shop.

recently found that one of its machines making rivets from aluminum wire had an abnormally high rejection rate because of smashed and malformed rivets. This machine had been checked and re-checked and was apparently identical with other machines working well.

A high speed camera filmed the machine at three thousand frames per second. Shown at only sixteen frames a second, the film quickly revealed that a weak spring was causing a pawl to seat improperly. The spring was replaced and the rejection rate dropped.

The high speed camera is basically a simple mechanism not calling for any special operating skill. It differs from an ordinary motion picture camera because the film passes through it in a continuous flow and does not stop momentarily between frames. In place of a shutter, a glass plate, mounted in a cylindrical housing, rotates behind the lens to provide frame separation and to allow exposures at the rate of from 1,000 to 3,200 frames per second.

In an ordinary motion picture camera the film is stopped and started for each frame, but this intermittent motion is impractical at speeds above two hundred and fifty frames per second.

In the high speed camera the optical image moves with the continuously moving film, being held on it long enough to expose the emulsion. This is done by rotating behind the lens an accurate plane-parallel glass plate of precise thickness, referred to as a rotating optical flat.

The picture below shows the actional diagrammatically. The few moving parts of the camera are driven by a built-in universal motor operating on 115 volts, a-c or d-c. Although in the field it is sometimes necessary

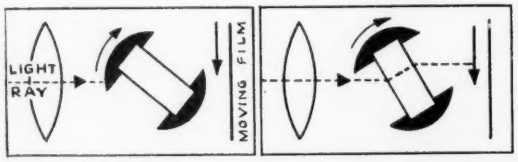
Shoot a motion picture, then leave production line noise to study it at leisure

Magnified 10 times, this macro-photo shows clearly the failure of a hinge deliberately tested to destruction.

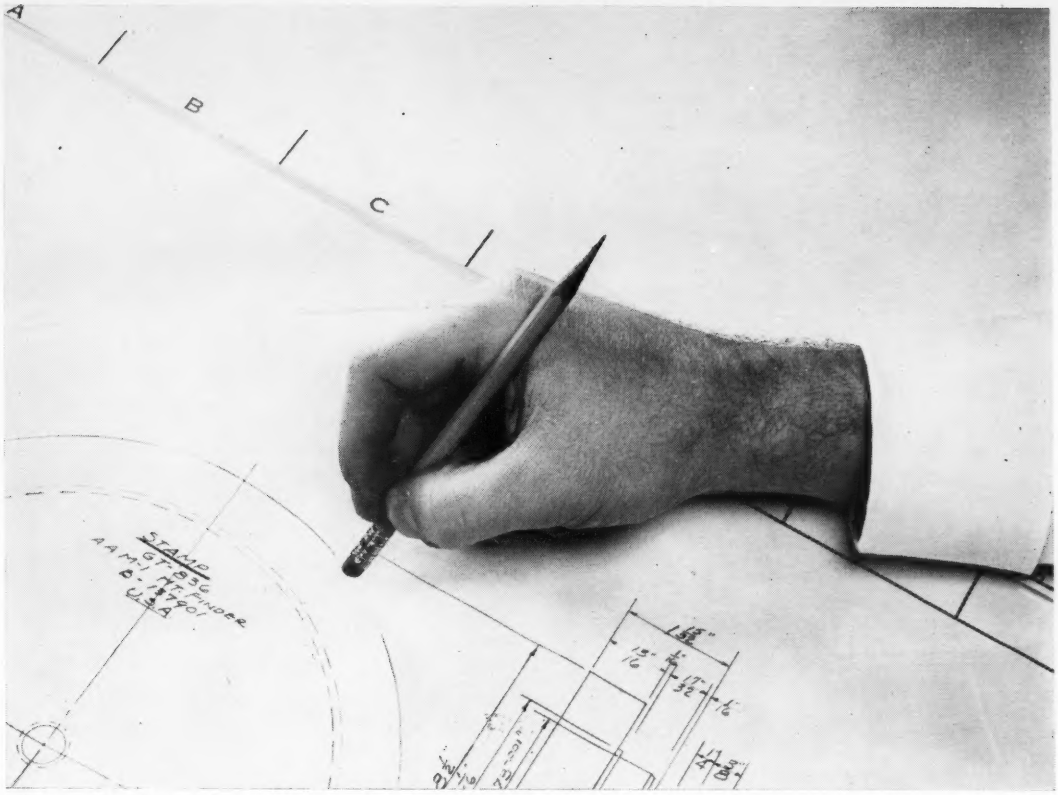
to use a dry cell battery, in which case the frame speed would be limited to 650 to 700 frames per second. Speed adjustment is by means of a rheostat with adjustable stop on the side of the camera. This same rheostat, mechanically coupled to the camera, prevents strain on the film and motor during the acceleration period. A motor shut-off switch, which can be set for 50 or 100 ft rolls of film, shuts off the motor automatically when the end of the film is reached.

For the higher operating speeds, 100-ft rolls are necessary because early footage is exposed before full speed is reached (see picture). It takes two or three seconds for speed to build up.

The movie camera is invaluable for the time and motion study man. It allows him to take his motion pictures then evaluate the various operations at his leisure, away from the noise and bustle of the production line. Every moment can be analyzed thoroughly and accurate time standards developed. Generally speaking, the camera should have single frame exposure facilities for



Here is how the motion picture camera works. Rotating framer replaces the usual shutter, cuts off light ray.



Photography does not make drawing board changes difficult. Lines on autopositive intermediate will rub out.

this purpose. A solenoid is used to work the shutter release and control is by a foolproof electronic circuit.

One firm, regular users of this technique, show all the films to employees and find that the employees themselves are often quick to see ways of streamlining their work.

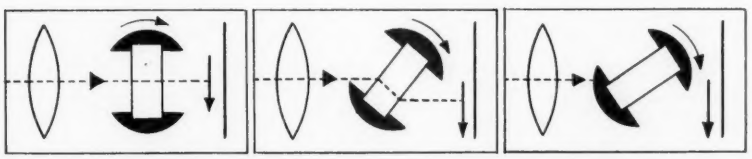
High speed movies can be combined with cathode ray oscillography for studying the behavior of electro-mechanical devices. In many non-electrical problems too, this combination allows easy co-relation with strain, acceleration, vibration and other signals supplied to the oscillograph.

To do this, the camera is modified by having a second lens mounted in the cover to record an image from a cathode — ray tube through the back of the film. The signal is applied to the horizontal deflecting circuit of the oscillograph only and the film travel provides a time base, calibrated, if necessary, by means of an edge-marking argon lamp.

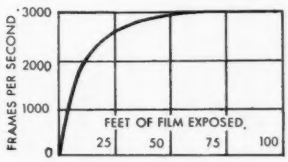
Exposure of the oscillograph trace is continuous — not intermittent like the exposure of the picture image. On any given picture frame, the mid-point from top to bottom of the trace coincides with the mid-point in exposure time of the picture image. The entire trace from top to bottom of the frame represents a time interval equal to the reciprocal of the picture frequency. This is five times the actual picture exposure time.

A camera with this attachment can obviously be used as a continuously moving film camera for record-oscillograph traces only on the back of the film. In this case the front lens is covered.

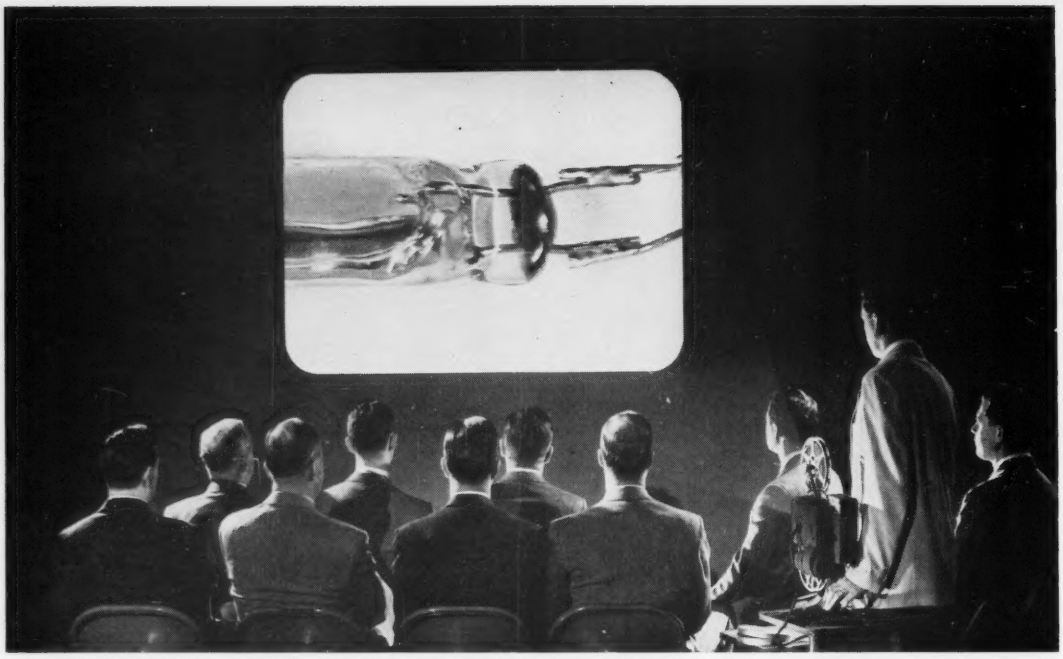
Microfilming of all types of records and documents is becoming widely known and used. The material is copied on photographic film at such a reduction that magnification is required for reading the film negatives. Modern equipment makes this a versatile and economical process with records copied on 16 mm, 35 mm or 70 mm film at a small fraction of their original size. Special "readers" magnify the image and photographic enlargements can be made at any time from the film. The resulting savings in size mean that record storage space can often be reduced as much as 98% and valuable floor space used much more productively.



until it nears the vertical. Ray then passes (slight refraction is unimportant) to the moving film behind.

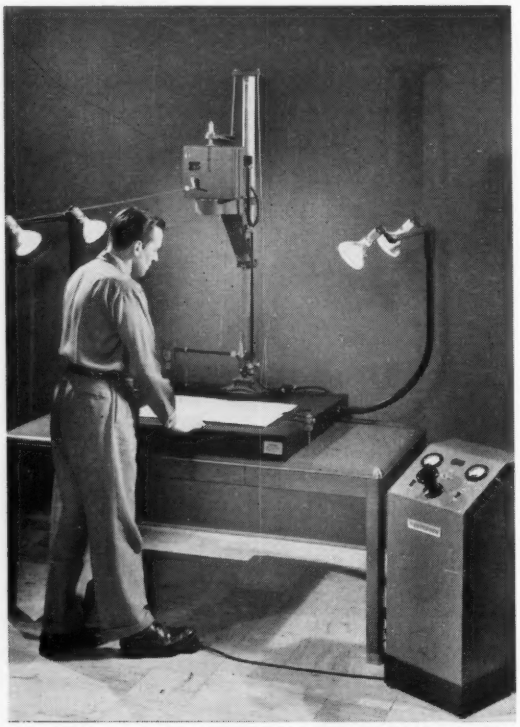


As framer rotates further, light is again obstructed. Graph gives footage exposed at varying frame speeds.



One of industry's current problems is education. What better teaching method is there than the modern movie?

Industrial photography *continued*



Are you short of storage space? Microfilm gear like this keeps your records and drawings to small scale.

Business and industry are finding the same economies in space and costs by the microfilming of records ranging from payrolls to shipping cards and engineering drawings.

An additional example of photography in design engineering and production comes from the use of Kodak Photo Resist, normally used for the production of printing plates and name plates. A Canadian aircraft firm, for instance, was having difficulty in producing templates for wind tunnel and other reduced-scale models of their aircraft. The job of cutting templates to very fine tolerances was difficult because chipping occurred when the normal paint-coating method was used. Photo Resist, which can be coated to a controlled thickness of one twenty-thousandth of an inch, proved to be the answer. Engineers are also able to make use of the fact that the lines were not printed *on*, but etched *in*, so that they produce a tiny groove which serves as a guide for the cutting machine.

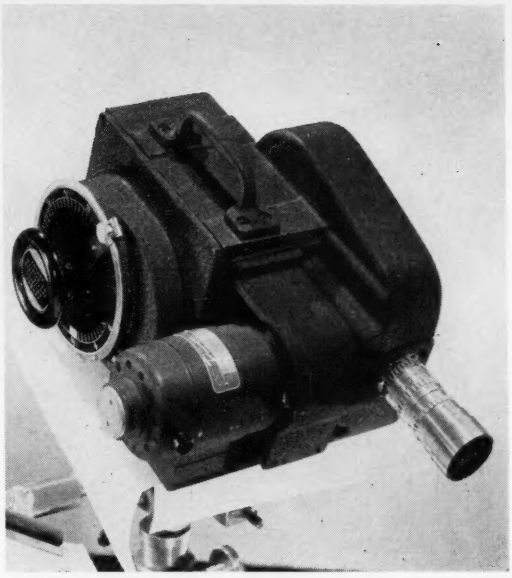
The use of photographs in production line work has enabled many firms to employ less-skilled men and women on jobs which formerly needed highly skilled operators. Semi-skilled persons can, for example, now assemble complicated electrical circuits by following color photographs of the completed panel or board. Vari-colored wire is easily traced on the photograph. Even inspection can be undertaken on the same basis simply by checking the circuit against the picture.

Flip charts of pictures showing assembly steps are now being used by many companies. As the work progresses, the employee simply flips over the pictures to follow his instructions. Such methods are proving especially valuable to those firms which occasionally have to shift production from one product to another. No refresher courses are then required. The correct flip chart is ready when the parts are, and the operator can go to work immediately, even though it may have been many months since he assembled that model.

Photography has opened new avenues in the field of material testing. The x-ray can point up material defects before machining (DESIGN ENGINEERING, June) with tremendous savings and improvements in quality. **Spectrum photography** can accurately record the composition of a given alloy, while **micro-photography,** through its capacity to record changes in crystal structures, is finding application in all fields of metallurgy. **Photoelastic stress analysis** on engineering models is of extreme value in the design of structures or moving parts. Time-lapse motion pictures can record every step in testing a material.

Stereo photography also has its uses in the research laboratory. Chemical firms have found that the three-dimensional views which are obtained with this technique give excellent records of equipment and apparatus set up for various experiments. When a procedure is to be duplicated, the stereo photograph gives an exact record of the equipment that was used before and of the way it worked.

Autoradiography is the exposure of photographic emulsions by contact with radioactive materials. A great variety of photographic products can be used for autoradiography, and the type of photographic material to be used depends upon the concentration of the isotope, activity, and rate of decay.



Modern high speed movie cameras shoot pictures at a rate of 3,000 a second. The one above is a Kodak.

Old, worn and soiled prints can be reclaimed with modern industrial camera

Other important fatcors are the grain size of the emulsion, the thickness of the section and the degree of contact between the section and the photographic material. Selection of the thickness of the emulsion on the photographic plate depends entirely upon the type of work which is to be done.

The Kine-theodolite camera, originally developed in Germany for checking the accuracy of shell bursts, is now used for the tracking of high speed missiles or models. By setting up a number of these cameras, a flight record of the elevation and azimuth is recorded. Velocities and trajectories can be found by analysis.

One of the most common uses of photography in business and industry today is in the reproduction of documents ranging from engineering and architectural drawings to correspondence and reports.

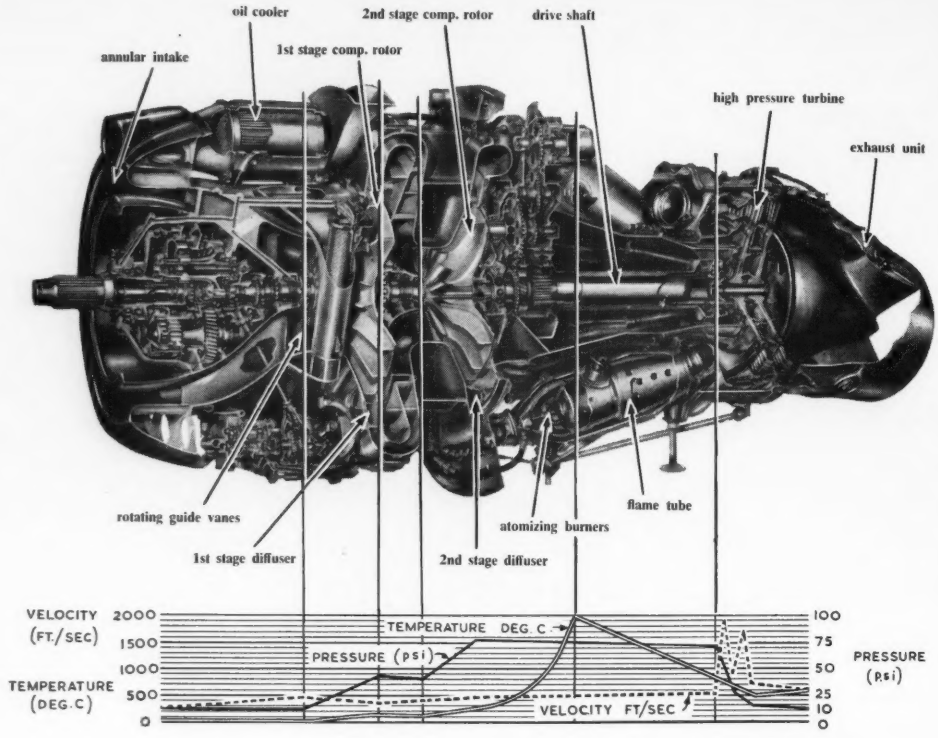
Originals of engineering drawings can easily be reproduced and used for print making, reference, mailing and revision. Old, worn and soiled drawings can be copied and reclaimed, while blueprints, direct-process prints and originals on heavy stock are quickly transformed into print-making masters. Drawings can also be quickly revised or combined through photographic copying techniques. Instead of tracing an entire drawing which needs revision, it is now possible to "scissor out" the unwanted part, substitute the new design and photocopy the result to get a completely new drawing. When certain design elements are used over and over in the preparation of new drawings, time and money can be saved by having these standard components reproduced on paper or film and using the reproductions to put together a totally new drawing. Lines and notations are added as required and the result is copied to produce a totally new drawing in short order.

Recent developments in photocopying methods have brought office-type machines within the budget range of almost every office. One such machine, the Verifax Copier, occupies no more space than a typewriter and can be operated in ordinary room light. In a minute's time it produces three copies of any letter or other office paper. Such machines are being used in countless ways at a fraction of the cost formerly necessary in hand-copying correspondence, orders, instructions, and other office papers. The latest development in this field, announced recently by the Eastman Kodak Company, combines the speed of this system with the office offset duplicator and now makes it possible to produce in less than a minute the master plate from which hundreds of copies can be duplicated.

Recent technological advances have brought with them unusual problems in training of all kinds. Many have started using films in education schemes. The new employee sees a film which explains the work of the company, how its products are used, how it operates, how employees benefit from management policies, and a host of other items which are important to employee morale and efficiency. Incidentally, the same film serves in many cases as a public and community relations tool for informing non-employees of the work.

Many advantages are offered by photography to a company which must train staff for new operations. Training can be concentrated in one location and therefore better controlled by the instructor. Any part of the instructional program can be repeated at will. Diagrammatic, superimposed images and cartoons can accent a point, demonstrate a procedure and even create humor.

The complexity of today's machinery brings problems of construction and maintenance which can be solved by photography. Huge assemblies, which must be torn down for shipping, are photographed during the entire assembly process. The resulting pictorial record reveals the exact order of assembly and the correct positioning of all parts. Pictures show the operator what the equipment looks like in all stages of assembly. ★



Temperatures, pressures and velocities in key parts of the compact Dart.

Sturdy Dart puts Reliability into Power

With fine conservatism, Rolls-Royce keep the well-tried centrifugal compressor but put high performance with reliability into their 'Dart' turbo prop engine

BY WILLIAM MORSE, P.Eng.

ENGINEERING EDITOR

THE ROLLS ROYCE "DART" engine uses a two-stage centrifugal compressor. Some engineers are surprised when they first learn that this is so. Most technical experts agree that the axial flow type is better for modern high-thrust propeller-turbine engines: So why, comes the question, does the Dart not have it?

Rolls Royce, of course, are as well aware as anyone of the merits and failings of the different compressor types. They agree that the axial compressor is more efficient (they used one in an earlier engine — the "Clyde") but their centrifugal model has been long and carefully developed; it dates back to the supercharger used in the famous "R" engine — which became the superb Merlin and Griffon; it was used by Frank Whittle in his early jet-engine development work. It has reached a stage now which is very close to perfection.

An Orenda engineer, asked to comment on the Dart's use of centrifugal compressors, thought it quite logical. "It's a little, wee, dinky engine," he said. "It's when you want very high thrusts that you have to go over to high efficiency axial flow compressors."

And it is true that the Dart is a small engine. At take-off it develops 1,400 shp plus 365 lb static thrust at 14,500 rpm. Compare this with the heftier Orenda, for instance, which develops more than 7,000 lb thrust.

Yet the Dart was chosen to power the swift Vickers Viscounts. Four Darts will cruise the Viscount with a full load of 48 passengers at 320 mph and an altitude of 22,000 ft. By Rolls Royce Dart and Vickers Viscount, New York is just 95 minutes away from Toronto.

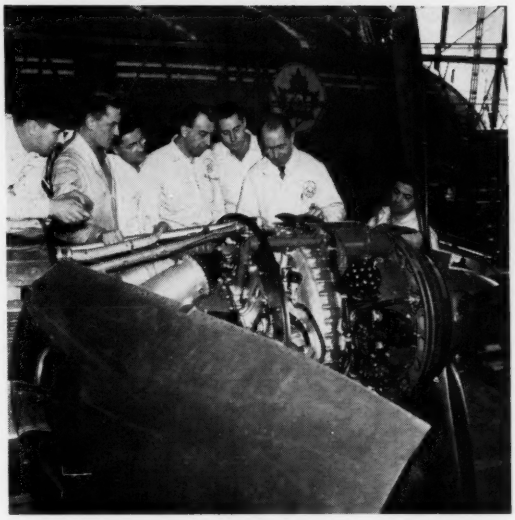
Design work started on the engine in 1945 and progressed fast. The two-stage centrifugal compressor was combined with a two-stage axial flow turbine in an engine designed for use in medium speed aircraft. By 1946, the first Dart was running. Since then it has gone through 17,000 hours of test bed and hangar running and over 9,000 development-flying hours in Viscounts. It is unquestionably a success.

Research on propeller turbine engines was started by the company before 1944, when the Clyde engine was undergoing development. Valuable experience (particularly on the problems of the high speed gearing associated with propeller turbine engines) was also won by modifying a Derwent turbo-jet engine to drive a propeller. This surprising hybrid, called the Trent, was installed in a Meteor aircraft and was the first propeller turbine engine in the world to fly.

The original Dart engine — designed for 1,000 hp at the propeller shaft — was found to be overweight. This was a serious problem the designers had to overcome. The material of the front casing, originally in aluminum alloy, was changed to a magnesium alloy. It sounds a simple step. But much research had to be put into the thickness of castings before safety could be guaranteed.

The compressor efficiency was improved by giving aerofoil sections to the diffuser vanes. Then shrouding of the turbine blades and the reduction of tip clearances gave a further increase in power.

The reduction gear was another problem. With an over-all reduction of .106 to 1, it was found that the spur tooth gears in the reduction train caused too much vibration. So helical tooth gears were introduced on the high speed train and the vibration was reduced.



To make sure their maintenance men thoroughly know the engine, TCA gives special courses on the Dart.

About 20 lb of air per second is drawn into the engine compressor through an annular air intake (See picture). A two-stage compressor increases the air pressure to about 75 psi and passes it into seven combustion chambers, designed to give correct mixing and combustion of the air with the fuel, which is sprayed in through atomizing burners.

The resulting high energy gas stream passes into a two-stage turbine — denoted in the picture by high pressure and low pressure turbine respectively — which converts most of the gas energy into shaft horsepower. The residual energy passes through the exhaust system to atmosphere in the form of a jet.

The turbine power is transmitted through a shaft to drive the engine compressor and the propeller (through a high ratio reduction gear). A small percentage of the shaft power is used to drive the various auxiliaries.

An annular air-intake duct leads the air to the eye

The Dart engine in brief

compressor	two stage centrifugal aerofoil sections for diffuser vanes
turbine	two stage axial flow
combustion chambers	seven, straight flow
prop. reduction gear ratio	0.106 to 1
prop. rotation	anti clockwise, viewed from rear
engine rotation	clockwise, viewed from rear
water methanol system	automatically progressive to restore power in tropics
starting system	electric high energy ignition. Sequence controlled automatically
fuel	av. kerosene D. Eng. RD 2482
frontal area	8 sq ft
length	95 in.
diameter	38 in.
engine weight	1,044 lbs (approx.)
oil consumption	less than 1 pint an hour

of the first compressor stage. An oil tank is cast around the air intake casing to form part of a self-contained lubrication system. The hot oil assists in keeping the air intake free of ice. The nose cowling is designed with a single entry oil cooler intake aperture at the top. This entry and the leading edge of the cowling are protected against icing by rubber-covered electrically-heated strips.

The high rotational speed of the engine main shaft is reduced to drive the propeller, through a reduction gear, so giving the best propulsive efficiency and propeller tip speed.

A splined coupling connects the front compressor shaft to a high speed pinion in the reduction gear. The helical teeth of the pinion engage with three layshafts, to produce the first speed reduction. At the forward end the layshafts engage, on spur teeth, with a rotating annulus wheel, which is locked to the propeller shaft. This second step-down provides the final speed reduction to about one tenth of the engine speed.

Oil tubes are inside

Oil tubes are carried inside the propeller shaft to pass high pressure oil for operation of the propeller pitch change and fine pitch stop mechanisms.

Other drives incorporated in the reduction gear assembly include those for the starter motor, oil pumps, fuel pump, propeller controller and the torque meter.

The axial thrust set up by the helical teeth in the reduction gear layshafts is proportional to the torque transmitted. This thrust is opposed by oil pressure from the torque meter pump acting on piston faces in the layshafts, one of which is arranged to uncover an oil bleed port as it moves rearwards. Torque meter oil pressure is thus controlled by the torque and becomes a measure of engine power at any given rpm.

The two-stage centrifugal compressor is strong and trouble free. The robust construction of the rotors makes the compressor less vulnerable to the passage of dirt and ice, when flying under adverse conditions.

Steel rotating guide vanes direct the air between the 19 rotor blades from which it is impelled at high speed. After passing through a diffuser the flow is directed through curved passages, formed by the compressor casings and interstage guide vanes, into the second rotor. This is of smaller diameter — 17.25 in. as against 20 in. — because it is dealing with air already partially compressed in the first stage.

The rotor shafts are supported by anti-friction bearings, the rear one being a ball race designed to take the end thrust.

Several tappings of air are taken from the compressors for cooling the turbine and pressurizing the bearing oil seals.

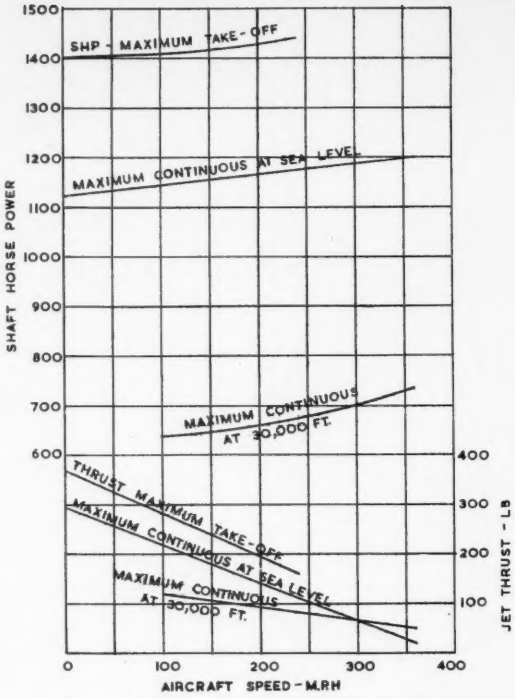
The two stages of the axial-flow turbine are locked together on a common shaft, which is located on a ball race at the rear end and coupled to the compressor shaft at the front.

Great care has been taken to produce a turbine of high efficiency and durability, by the use of heat-resisting materials of low creep characteristics.

The blades of the high and low pressure stages are carried on "fir-tree" serrated roots, in their respective discs. Both discs are cooled on their front and rear faces by air tapped from the compressor.

Between the stages is a steel-strip seal to prevent gas leakage. The turbine, and the compressor are each dynamically balanced to fine limits.

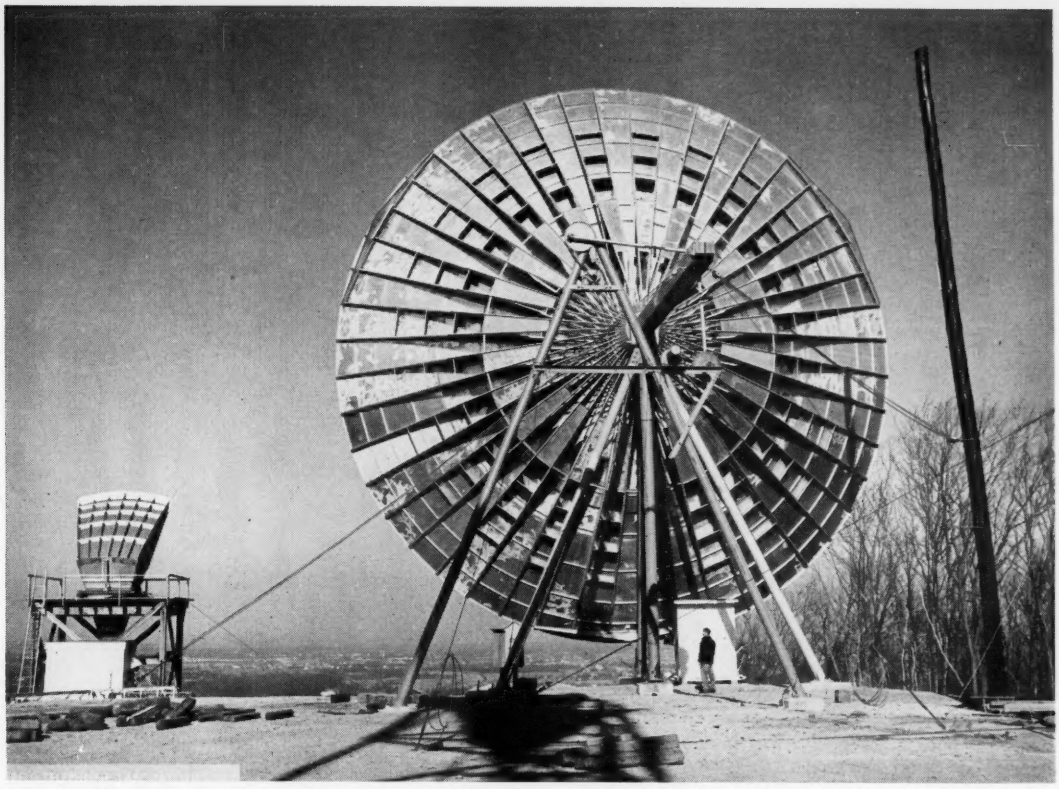
Each of the seven combustion chambers consists of an outside casting, an aluminized steel air casing and a flame tube in Nimonic 75, Primary air for combustion is metered into the flame tube through a series of holes and a set of fixed swirl vanes in the head of the tube. The remaining holes are positioned to produce an even and acceptable temperature of the gas stream flowing into the nozzle box and turbine. A further air flow occurs over the outer wall of the flame tube. Fuel is sprayed downstream into each flame tube from a burner positioned in the centre of the **(Continued on page 52)**



Performance figures at two levels — sea and 30,000 ft., under international (ICAN) standard conditions.

Performance at Sea Level

condition	engine rpm	aircraft mph	power bhp	thrust lb
take off	14,500	0	1,400	365
max. continuous	13,800	0	1,120	295
		200	1,161	140
		300	1,184	62
		350	1,197	21



The world's largest antenna — from the rear. It picks up television and telephone signals at 200 mile range.

Television Reaches Seven Times as Far

New large antennas can throw television waves 200 miles over the horizon

DIRECT TELEVISION and multi-channel telephone transmission reaching 200 miles without relay stations and at ultra-high frequencies, has come now from Bell Telephone Laboratories and the Massachusetts Institute of Technology.

Television pictures, as well as radio and telephone conversation, can be sent over-the-horizon* on ultra-high frequencies; here is a peaceful extension of a transmission technique applied to the continental defense system.

The main advantage of this system of transmission is that better communication is possible over water and rugged terrain. Remember that in the present microwave radio relay network across the U. S., relay stations are 30 miles apart.

Standard AM radio broadcasting employs waves that follow the earth's curve whilst waves used in television and telephone relays were assumed to travel in a straight line. For many years, "line of sight" transmission between antennas located on towers about 30 miles apart was thought to be the only practical method of transmitting by radio the wide bands needed for television and multi-channel telephone service.

This was disproved by research at Bell Telephone Laboratories and MIT. The Bell Laboratories' research stemmed from their success with transcontinental microwave systems for carrying telephone conversations, radio and television programs from coast to coast and their continued interest in radio propagation. The MIT interest was stimulated by government radar work.

Scientists knew that ultra-high frequencies traveled over-the-horizon under certain conditions but believed that they were too weak and unreliable to be useful.

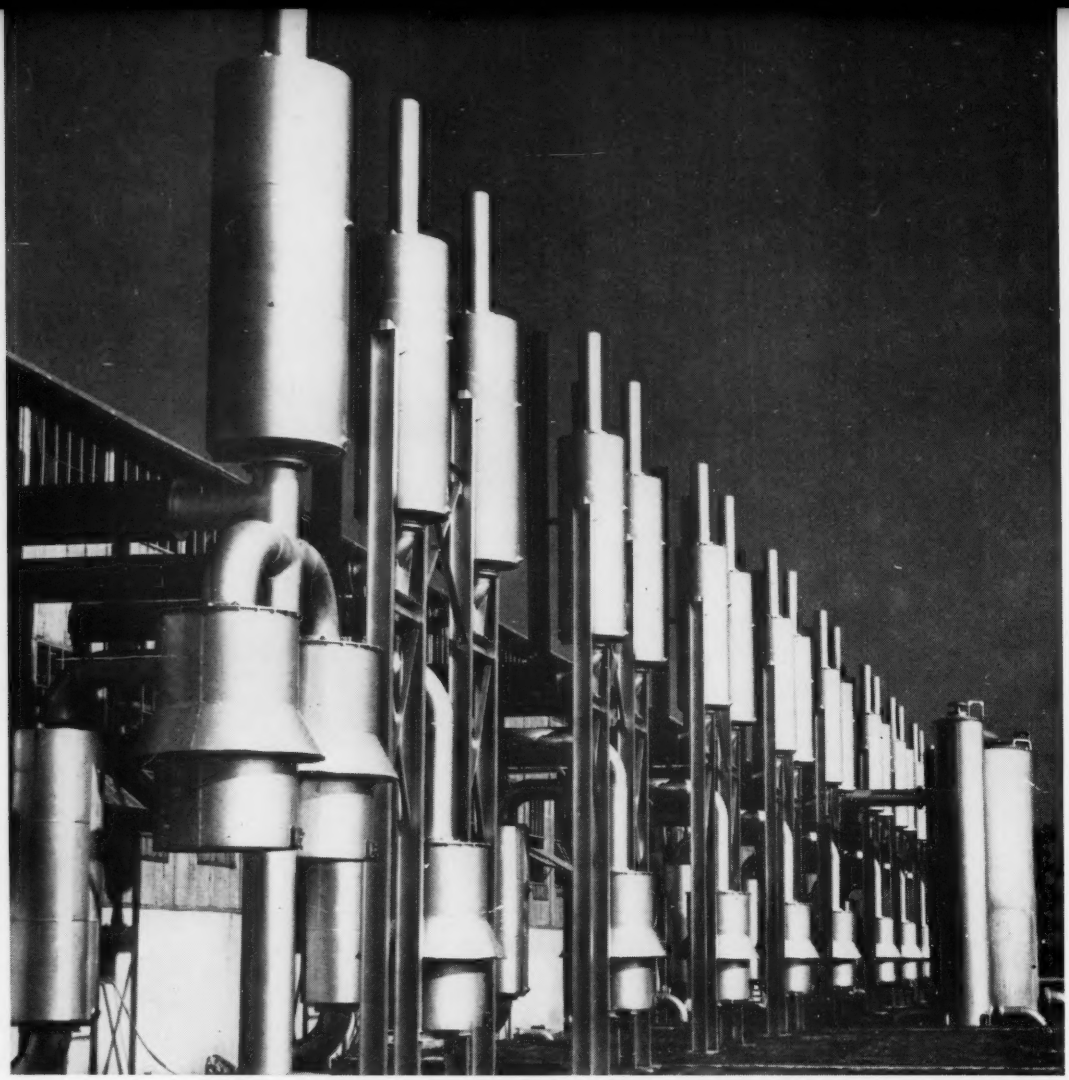
While checking into interference from these waves, it was discovered that many actually overshot the relay towers they were aimed at and consistently arrived at more distant points.

The next step was to provide reliable long distance transmission "over-the-horizon." This was done by erecting larger antennas and using higher power than is employed in conventional microwave systems. So use was made of the weaker signals that drop off a straight radio beam beyond the horizon and are reflected or scattered to distant points by the atmosphere.

The effect of the new system is very like that of a powerful searchlight, which casts a beam in a straight line. A searchlight aimed at the sky can be seen from the ground miles away, even when the searchlight is behind a hill, because some of the light is reflected to the ground by the atmosphere.

In order to make use **(Continued on page 52)**

*Not to be confused with ionospheric scatter which is useful in long distance transmission of telegraph signals at low frequencies.



Aluminum silicone paint on these compressor exhaust mufflers stood up to over 400 deg. C. for three years.

Why You Should Use the Silicone Protectives

By W. C. KRANE, P.Eng.

DOW CORNING SILICONES LIMITED

Silicones have come a long way. Although chemically inert, they stand temperatures that harm most organics

THE STRANGE hybrid silicone family offers industry a rare combination of properties. It is a family of semi-organic materials with much of the stability and good dielectric behavior of glass, quartz and the mineral silicates. Yet these same materials have flexibility, solvent solubility, ease of handling and repel water—qualities inherited from the organic half of their nature.

Silicones in all their various forms are stable at temperatures in the range of 50 to 100 deg. C above the limits of comparable organic materials. They are relatively inert chemically and show excellent resistance to oxidation.

In recent years the cost of silicone resins has dropped. So nowadays there are few applications where cost rules out the silicone coatings. Retail prices range from $10 to $30 per gallon. A straight silicone enamel with maximum heat resistance, gloss retention and guaranteed non-yellowing characteristics can be had at about $20 per gallon.

Even today many people confuse silicones with the silicas and the silicates. It is true that they are all silicon-containing compounds, but there is no other similarity.

The silicones are not found in nature. They are compounds which had first to be synthesized before they could be studied. Indeed, many problems had to be solved before the silicone resins were made commercially.

Professor Kipping, working at the University of

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Nottingham, spent his lifetime studying these weird inorganic—yet organic—materials. Using the Grignard method of synthesis, he was able to prepare a large number of organosilicon compounds. It was his work that laid the foundation for our present knowledge in this still-new field of chemistry.

About 1930, the Corning Glass Works developed a method of weaving glass cloth. One of the big markets for this cloth was in the field of electrical insulation. Corning needed an electrical insulating varnish with which to impregnate the glass cloth. This varnish had to be similar to conventional organic varnishes and yet be heat stable—to complement the use of the glass cloth.

Dr. Hyde developed this product at the Corning Research Centre. The resinous gums, considered a nuisance in Kipping test tubes, proved to be what Hyde was searching for.

The production of silicones on a commercial scale began in 1943 and quickly expanded as new products were developed and perfected. This silicone family was nurtured by the modern trend toward high temperature. Some branches of the family performed so well as to be beyond the fondest dreams of design engineers. For example, silicone electrical insulation results in motors which outlast conventional motors over one hundred times; silicone lubricants are useful for long periods at 450 deg F and as permanent lubricants at room temperature; Silastic remains flexible and rubber-like from —100 to 500 deg. F; and lastly, coatings give good protection against weathering and corrosion at temperatures up to 1,000 deg F.

Most often conventional oils, rubbers and resins are hydrocarbons. Silicones and hydrocarbons behave as differently as silicon and carbon, for although these two elements are in the same group in the periodic table and are both tetravalent, they react quite differently with other elements. This is particularly true of chlorine, oxygen and carbon itself, the three elements most important in silicone chemistry.

So, carbon dioxide is a gas, while silicon dioxide is a very heat stable solid known as sand or quartz. Carbon tetrachloride is stable in the presence of water while silicon tetrachloride forms silica and hydrochloric acid.

The two most important linkages in silicone chemistry are the silicon-to-oxygen and the silicon-to-carbon bonds. Silicones are built on a molecular skeleton of silicon-oxygen atoms just as hydrocarbons are built on a skeleton of carbon-to-carbon atoms. The bond energy of Si-O linkage, however, is about one and a half times as great as the bond energy of the C-C linkage. Furthermore, the Si-C linkage is strong and relatively heat stable, especially when the organic group is small and compact.

Silicones are made two ways

Silicones are made by two general methods: substitution and direct. In the substitution method a silicon compound, such as silicon tetrachloride or tetraethyl-orthosilicate, is used and the halide or ester group replaced by organic groups through one or more reaction steps. Of the several substitution methods known, the Grignard method is the most important so far.

In the direct method, silicon is reacted directly with a hydrocarbon halide, such as methyl chloride, to form the organochlorosilanes. The basic chemical reactions of both these methods are:

Grignard Reaction—

1 $RMgCl + SiCl_4 \longrightarrow \begin{matrix} RSiCl_3 \\ R_2SiCl_2 \\ R_3SiCl_3 \end{matrix} + MgCl_2$

2 Direct Synthesis

$$RCl + Si \xrightarrow[\text{heat}]{\text{Catalyst}} \begin{matrix} RSiCl_3 \\ R_2SiCl_2 \\ R_3SiCl_3 \end{matrix}$$

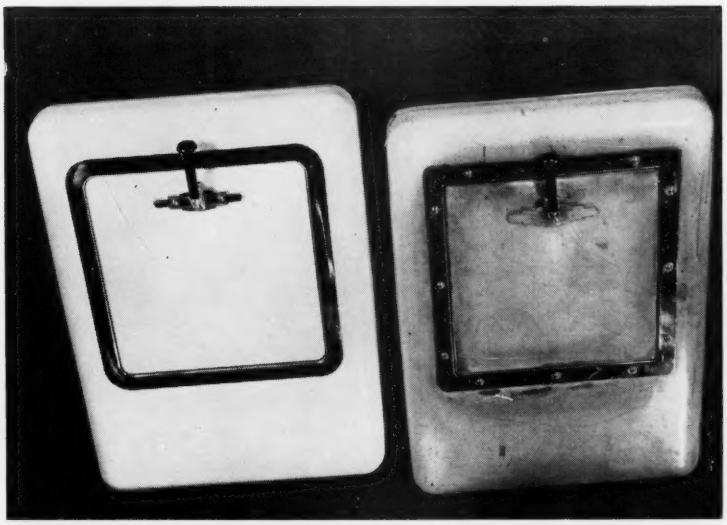
organochlorosilanes

The organochlorosilanes can be prepared by either method and separated by distillation into the various intermediate products. From this point on the process is the same, namely that of hydrolysis and condensation.

3 Hydrolysis

$$\begin{matrix} RSiCl_3 \\ R_2SiCl_2 \\ R_3SiCl_2 \end{matrix} + XH_2O \longrightarrow \begin{matrix} RSi(OH)_3 \\ R_2Si(OH)_2 \\ R_3SiOH \end{matrix} + XHCL$$

organosilanols

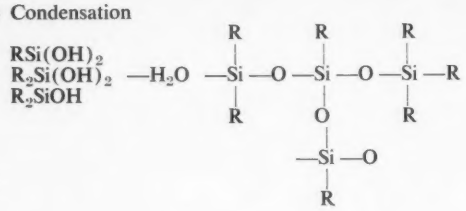


Silicone-modified white enamel on the incinerator door (left) survived heat unscathed. Compare it with discolored ordinary coating beside it.

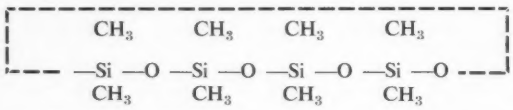
Silicone enamel, used on this space heater, stays bright at 500 deg. F.

Use Silicones *continued*

4 Condensation



The physical form and properties of the finished material are determined by the organic radicals involved and by the degree of substitution. The degree of substitution (or R/Si ratio) depends on the choice of the organochlorosilane intermediates. For example, when an organodichlorosilane (RSiCl with R a methyl group), is hydrolyzed and condensed, a liquid polymer is formed either in a linear or cyclic form.



The R/Si ratio is 2.0 with two methyl groups attached to each silicon atom. A monofunctional unit such as the trimethylmonochlorosilane can be introduced into the polymer as a chain stopper to control viscosity.

The products made from the mono- and difunctional intermediates are liquids and non-curing because they are not cross-bridged. However, by the introduction of trifunctional and possibly small amounts of tetrafunctional units into the polymer, cross-bridging occurs which results in resinous solids. By varying the R/Si ratio and the choice of the organic radical, it is possible to obtain resins which are very flexible and slow curing or those which are hard, brittle and fast curing.

As mentioned earlier, silicones were first used as an electrical insulating varnish, to impregnate glass cloth and for dipping coils, motors and so on. It has taken about fifteen years for the next most obvious step — the use of silicone varnish for insulating bare copper wire. However, this silicone bare wire enamel, as it is called, is now a practical reality, and silicone coated copper wire is commercially available. At room temperature it has the physical properties of conventional coatings, and is far better at temperatures up to 180 deg. C continuously.

In the field of decorative and protective paint films, the silicone resins are useful in the temperature range 350 to 1,000 deg. F. Up to 350 deg. F conventional coatings (based on oleo-resinous varnishes, alkyd, urea-formaldehyde, melamine-formaldehyde, triazine formaldehyde, vinyl, rosin, acrylic, solubilized rubber, terpene and hydrocarbon resins) are satisfactory. From 350 to about 500 deg. F the silicone-alkyd or silicone-phenolic resins, generally referred to as modified silicone resins and conventional pigments, may be used. For continuous service at 500 to 600 deg. F, 100% silicone resins, using ceramic pigments, are required.

For extreme temperatures up to 1,000 deg. F, it is normal to use aluminum pigmented or black formulations. These give excellent protection to refinery cracking coil stacks (see picture), foundry exhausts, diesel or gasoline engine exhaust mufflers and the like.

The coming of these heat resistant protective coatings has in some cases led to simpler design. For example, the re-design of one oil burning space heater, finished in silicone enamel, lessened the amount of insulation and the number of baffles required to keep the outer shell cool. These design savings were appreciably greater than the slightly increased cost of the finish used.

At the present time one manufacturer of these burners turns out a light beige model (see picture). Although skin temperatures reach 500 deg. F, he is demanding and getting a silicone enamel at a reasonable price which fully meets his requirements of abrasion resistance, adhesion, color fastness (no darkening) and gloss retention.

It should be pointed out that surface preparation is important. The metal should be free from heavy scale and rust. A lightly rusted surface, however, does not

chemical action on white silicone coat

	Rating after immersion at 70 deg. F			Rating after immersion at 100 deg. F		
	3 hr	20 hr	100 hr	3 hr	20 hr	100 hr
Chemical reagent						
Acetic acid, 2%	E	E	E	E	E	E
Hydrochloric acid, 2%	E	E	E	E	G	G
Nitric acid, 2%	E	E	E	E	G	G
Phosphoric acid, 2%	E	E	E	E	E	E
Sulphuric acid, 2%	E	E	E	E	G	G
Sodium Hydroxide, 2%	E	E	G	E	E	O
Butyl alcohol	E	E	E	E	E	E
Kerosene	E	E	E	E	E-x	E-x
Sodium Chloride, 2%	E	E	E	E	E	E
Linseed oil	E	E	E	E	E	E
Oil (SAE 30)	E	E	E	E	E	E
Petroleum grease	E	E	E	E	E	E

E means Excellent; G, good; O, serious failure; Ex, edges attacked.

chemical action on unpigmented silicone

Resin DC 805

Cure 1 hr at 250 deg. C.

Chemical resistance after 100 hours exposure in

	HCL	H_2SO_4	HNO_3	NaOH
At 5% strength	NE	NE	NE	NE
At 50% strength	NE	NE	NE	NE
Concentrated	NE	F	F	F

These results were obtained by immersing 1 mil. thick film in the chemical solutions kept at 106 deg. F.

NE means no effect; F, film hazed.

seem to matter. At temperatures below 650 deg. F silicone primers, formulated using conventional zinc chromate and iron oxide pigments, can be used to advantage. A coat of this primer, followed by an aluminum or colored top coat, gives excellent corrosion protection.

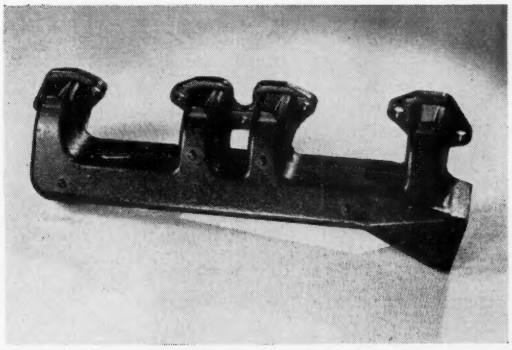
The hydrophobic characteristics of the silicone resins are made use of in the silicone masonry water repellents. In the form of a 5% silicone resin solution in solvent, it is sprayed on exterior, above grade masonry walls. The solvent carries the resin into the pores of the brick where it deposits as a lining on the inside of each pore. Only enough resin is used to prevent water penetration. There is no change in the color or texture of the masonry wall, even the lightest shades of brick. Breathing of moisture vapor from the interior of the building is not interfered with because of the relatively high moisture vapor transmission of the thin layer of resin.

Keeps dirt outside

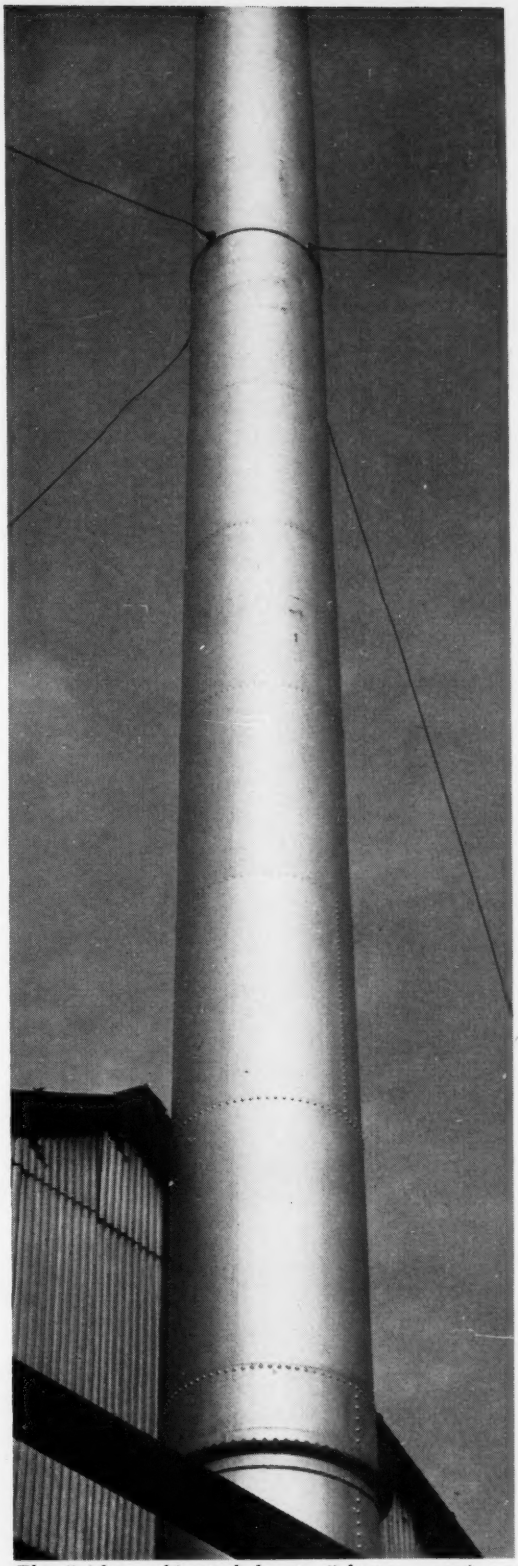
By keeping water from penetrating into the masonry, the silicone treatment prevents surface dirt from being carried into the pores of the brick. White efflorescence will not appear on a treated surface, and, of course, the spalling sometimes experienced due to alternate freezing and thawing is avoided. There is a market saving in heat loss when interior walls are kept dry. Not only is there a great reduction in the rate of heat transfer but no heat is used up in drying out the walls.

In a very real sense the silicone masonry water repellent is a protective coating for masonry construction.

Research and development in the field of silicone based coatings continues. One of the main targets is a silicone resin which will give superior performance as a vehicle in exterior paints. This is a large and attractive market which can only be reached through the paint manufacturing industry, which itself is in a state of rapid technicological change. Price is a big factor in this field and here is one reason why the silicone resins have had to be modified with alkyd or sometimes phenolic resins. Another reason is that only in this way can we get the necessary air drying characteristic. The first silicone-containing exterior house paint to reach the market will be a premium priced product and it will be guaranteed to outlast currently used products by many years. ★



Ford engine manifolds are finished in black silicone enamel for eye appeal with a long lasting protection.



The finish on this stack has to fight two enemies — weather and heat. So a silicone aluminum was used.

Built of existing parts, the gaunt and graceless new Bell aircraft threatens most current aviation ideas.

U.S. Builds the Airplane of Tomorrow

This VTOL-type aircraft, the first of its kind, is taking designers to new thoughts on aviation. Made up of existing parts, it has a weird appearance — but stands among the most exciting experiments being seen today

USING A QUITE NEW principle of flight, Bell Aircraft Corporation has built and flown a jet-propelled vertical-rising airplane which takes off and lands without need for a runway.

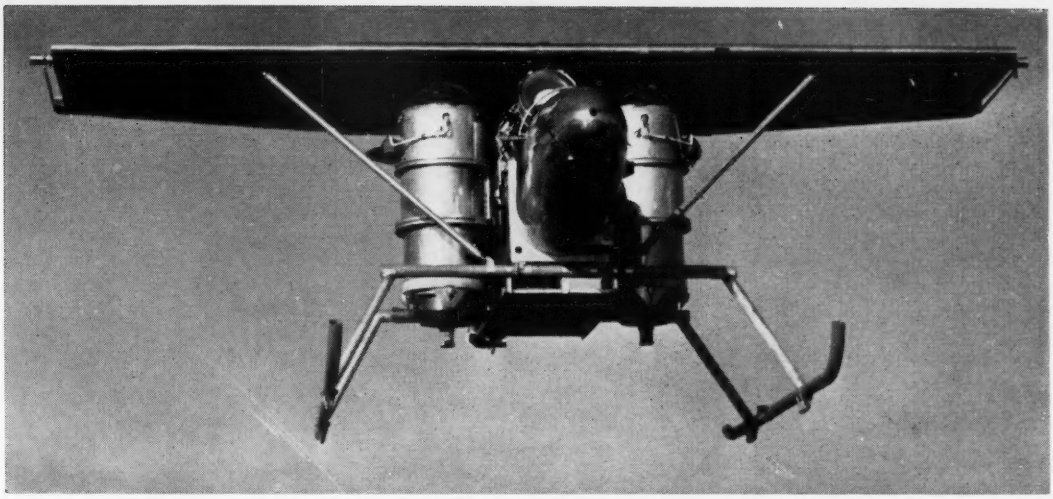
First of its kind to be flown anywhere, the new Bell development is a VTOL (vertical take-off and landing) airplane which uses twin jet engines to provide thrust for vertical operation and horizontal flight.

Unlike the so-called "tail sitter" the new Bell VTOL plane takes off and lands in a normal horizontal position, so eliminating the need for special ground-handling equipment and crews.

Two Fairchild J-44 Turbojet engines, each delivering about 1,000 pounds of thrust, rotate from a vertical position for take-off and landing to a horizontal position for forward flight. But with this exception, the Bell VTOL performs like a conventional fixed-wing airplane.

The test vehicle weighs about 2,000 pounds, is 21 feet long and has a wing span of 26 feet. It carries only the pilot.

For take-off and low speed flights, compressed air is ejected from nozzles at the wing tips and the tail of the aircraft to provide pitch, yaw and roll control. When



With Fairchild engines rotated, the new aircraft sits on 2,000 lbs. of up-thrust, motionless and 8 ft. high.

sufficient forward speed is attained, flight control is provided by conventional control surfaces, ailerons, rudder and elevators.

The construction of this airplane was influenced by an old maxim of engineering design: When examining a new and unconventional item, keep as many of the other parts as conventional as possible. In other words, walk first and hope to run later.

The aim was to take off vertically with jet power to maintain controlled hovering and to change from vertical to normal horizontal flight.

The usual need for high speed and aerodynamic cleanliness was not important at this stage of the struggle. As a result of this philosophy, the airplane was put together from such existing parts as a Schweizer glider fuselage and empennage, a modified Cessna wing, a Bell helicopter landing skid, two J-44 engines and a Palouste turbocompressor for compressed air.

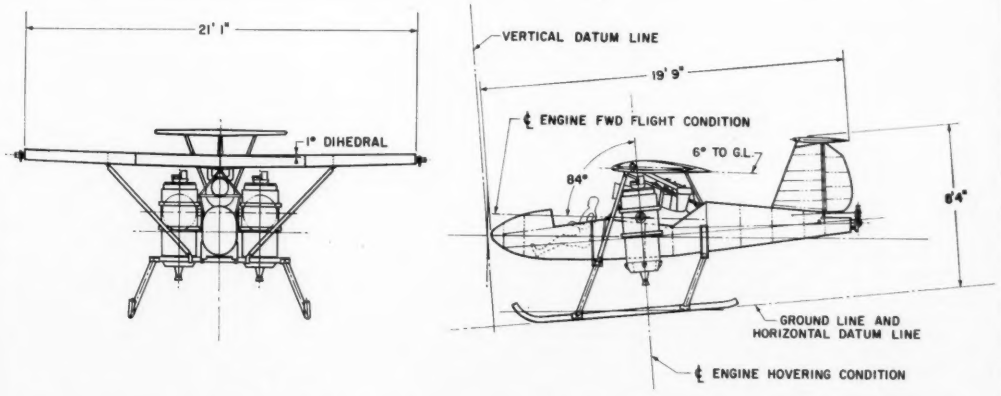
A method of moving the thrust from vertical to horizontal was needed and the designers might have left the engines horizontal and used a rotating tail pipe bend. This would have imposed certain indeterminate losses on the thrust and would have presented a fairly complicated design problem.

In the interests of simplicity the whole engine is rotated, leaving the engine virtually untouched and giving a maximum thrust.

Like the helicopter which brought new maneuverability and utility to aircraft, the jet powered VTOL launches an entirely new era of fixed wing flight.

By combining jet propulsion and vertical flight characteristics there is no need for the long runways, some of them more than two miles in length, now required for high speed jet fighter and bomber airplanes.

The same principle may later be applied to commercial aircraft of much bigger size. ★



The mathematics of VTOL flight. Set the motors facing aft and the plane becomes an ordinary jet.

Pouring the melt. The steel rod plug is lifted and molten steel runs into the mold leaving dross behind.

The Tricky Steel Casting Gains Favor

There is a place for the steel casting even in precision work. When it replaces a forging, it can save money But you have to be sure of standards

By R. SMALLMAN - TEW
AVRO AIRCRAFT LTD.

PROPERLY DESIGNED steel castings have their own place in aircraft and other precision structures when they replace forgings, with difficult machining shapes. Where a steel casting can replace an assembly of forged or machined steel parts weight and machining costs will be saved.

Steel is always attractive when light alloy components are too big for a confined space; and a steel casting, whose mechanical properties are, of course, isotropic has a big advantage over a light alloy forging whose cross grain-strength, and especially ductility, are so much reduced. A final feature which makes a steel casting better is when small numbers of a steel component are required as, for instance, with prototype aircraft and where the manufacture of forging dies would be too dear and would take too long.

The choice between a steel casting, a steel forging or a machined part, obviously depends on which provides the highest strength-to-weight ratio combined with a low cost of finish-machined product and early delivery.

A further point is that an intricate shape can be cast without too much difficulty if care is used in pattern and core making and shrinkage; internal defects should be removed by the proper positioning of gates and risers based on a careful scrutiny of radiographs of development castings. An intricate shape will be difficult to forge and may need a number of complex and costly dies. As for machining from the solid, this is only competitive on very simple shapes. A particular component which the author handled recently could have been machined from a block of alloy steel weighing 900 lbs. The same component would have weighed 450 lbs as a forging. But the calculated weight as a rough casting was 200 lbs or 135 lbs finished.

It should not be imagined that anyone can design a steel casting—or that any foundry can make it. Rules have to be obeyed and the best results come when the designer shows the foundry what he would like to have but both parties feel willing to make minor concessions.

The design of most castings which the author deals with have areas which are highly stressed and areas which are stressed a lesser amount. The highly stressed areas are marked on the drawing and no defects are allowed in the casting there. Small defects in other parts of the casting go to arbitration and a minimum acceptance standard is fixed for them—this standard being determined for each individual type of casting.

The mechanical properties of steel castings, some covered by Federal Specification QQ-S-681 and two other interesting ones of automobile quality, are listed (see table 1). Although the specification gives the minimum strength requirements of the castings, it lacks information on the chemical composition of the steels which are used. The exception is for Class 1 castings, which are straight 0.30% carbon steel. For all other analyses, only the sulphur and phosphorus are specified, and these at 0.05% maximum.

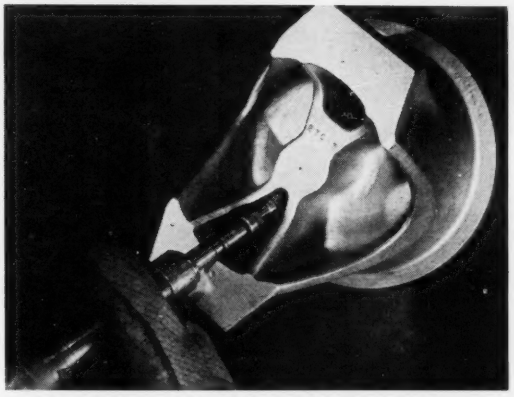
Details of aircraft quality steel castings, based on British specifications DTD 666 and DTD 705, are listed (table 2). Here again, the specified chemical composition is limited to sulphur and phosphorus, which differ from QQ-S-681 by being restricted to lower maximum contents, 0.020% sulphur and 0.025% phosphorus.

A comparison of these two tables shows that DTD 666 falls between Classes 4C3 and 4C4 for strength properties, but that it has a higher required impact value, whilst DTD 705 approximates to the 175 ksi U.T.S. steel casting of Table 1.

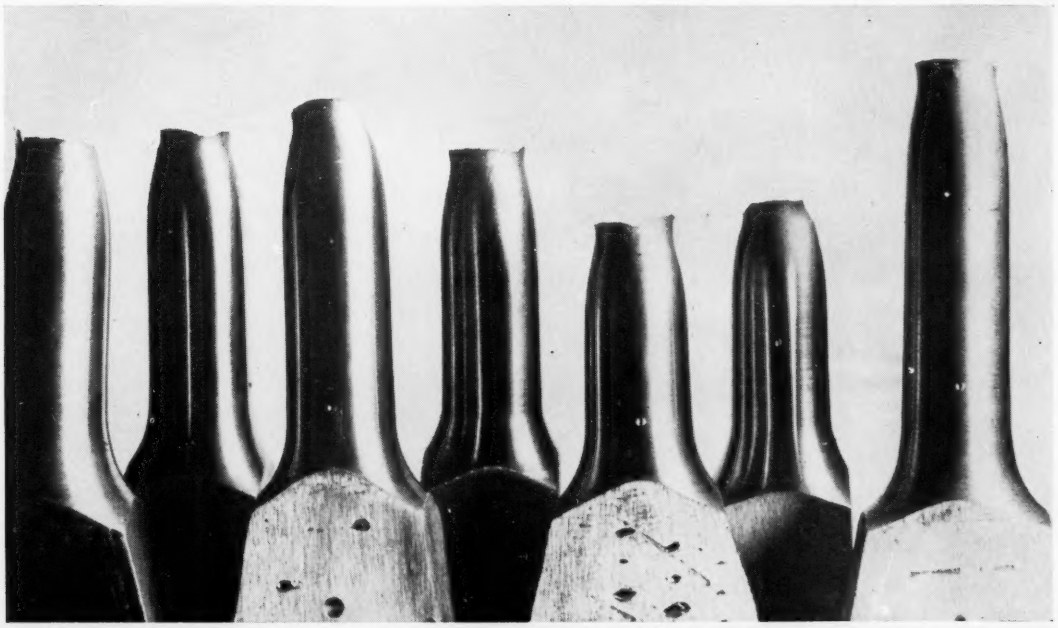
What then is remarkable about these high tensile, aircraft quality steel castings, which appear to have their counterparts in the Federal Specifications?

The answer most probably lies in the words, "aircraft quality," and that, through meticulous care

Rough faced steel castings as they come from the mold (left). And (on the right) as they are after fettling.



Fettling is done with high-speed hard steel burrs. It takes off skin roughness, leaves the casting polished.



Cast steel is ductile. These test specimens (which have had their tops pulled) prove it in tension.

More evidence of ductility in cast steel. These test specimens were vee-notched, then fractured by impact.

Steel castings have already been used for aircraft parts, will be used again

Steel Castings *continued*

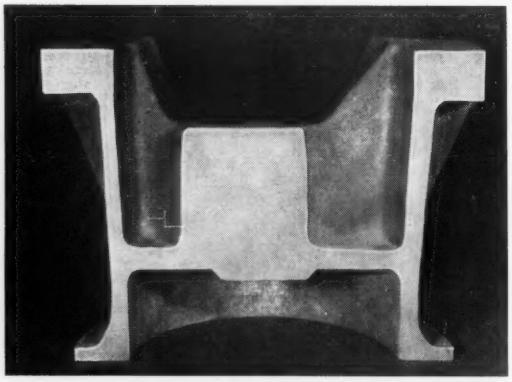
throughout the foundry operations and later inspection, these castings have all the attributes of steel forgings and have actually been used in modern aircraft in the place of forgings.

The history of steel castings for highly stressed parts of the primary aircraft structure can be traced back to the early 1930's, at which time aircraft designers in Britain, America, France and Germany considered their potentialities. The fact that they were not much used in aircraft construction was not because they were unsuitable but rather because castings of the required quality and consistency could not be produced economically.

To a German—Dr. von Eckartsburg—goes credit for being the first to obtain the required high standard in these steel castings. By 1938, the Annen foundries of Ruhrstahl A. G. were turning out production quan tities for the German aircraft industry, and confirmation of their extended use on Junkers, Messerschmidt and Dornier aircraft was obtained from the large number of these aircraft shot down over Southern England during the Battle of Britain in 1940.

These steel castings were used at wing-centre section pick up points, for knuckle joints or wheel axle joints in main undercarriages and for a number of other highly stressed parts of the aircraft structure. They were used where they not only replaced steel forgings but did so without weight penalty, using the same design factors as for forgings. Undoubtedly, the Germans had great confidence in the manufacturing skill of the foundry and in the integrity of their designers and inspectors.

Following the finding of the steel castings on the shot-down German aircraft, the British aircraft industry was quick to show interest. An experimental foundry was set up at David Brown Foundries Limited, near Sheffield, under the sponsorship of the Ministry of Aircraft Production, to develop and produce aircraft steel castings to a standard equal to those produced by the Germans. This foundry began its special operation in 1943, and by 1945 had produced a number of highly successful steel castings, which were used in the primary structure of prototype British aircraft. One example was the folding wing joint of the "Barracuda" the famous carrier-borne, reconnaissance light bomber.



A typical steel casting split down the middle to show the deep sharp pockets that come easily from casting.

Cast steel has a very uniform texture. This microphoto (magnified 630 times) proves its fine grain.

	C QQ-S-681 Class 1	C QQ-S-681 Class 3	A QQ-S-681 Class 4A1	C	A QQ-S-681 Class 4B3	A QQ-S-681 Class 4C3	A QQ-S-681 Class 4C4	A
Ultimate Tensile Strength ksi	60	80	80	100	100	120	150	175
Yield Strength ksi	30	45	50	70	68	95	125	148
Elongation %	32	26	24	20	20	16	12	8
Reduction in Area %	55	43	50	46	42	38	25	20
Hardness BHN	120	160	170	200	209	245	300	340
Izod Impact (ft lb at 70 deg F)	30	25	30	30	22	20	14	10
Fatigue Strength ksi	25	35	38	47	45	55	65	77
Condition .....Ann.		N & T	N & T	N & T	N & T	H & T	H & T	H & T

A means alloy steel; Ann, annealed; C, carbon steel; H, hardened; N, normalized; T, tempered.

One difference between the German and the British steel castings was the use by Britain of the vertical centrifugal method of casting, whereby the molten metal is poured into a rotating mold. The reason for its use is that when a fine stream of molten metal is poured from a central sprue, the mold being rotated at between 250 and 450 rpm, the metal impinges against the farthest surface of the mold cavity where it freezes rapidly and ejects any dissolved gas at the hot face. This gives progressive solidification and a finer grain size than usual with almost complete absence of dendrites. Any gas and impurities that are present are forced to the sprue, where they can do no harm. Another advantage is that a number of small castings can be made with one pour, by grouping the mold cavities round the periphery of the mold, each being connected to the central sprue by a series of runners radiating like the spokes of a wheel. Centrifugal casting is not a "must" by any means, but is a useful technique.

All foundries making aircraft castings, whether they are of light alloy or steel, have to be officially approved after very careful examination of the foundry.

The foundry must have the right equipment for turning out a first-class product. It must also have facilities for analyzing the heats produced and for physically testing the cast test bars which are required, by specification, to prove each heat. It must be equipped with radiographic apparatus, and approved personnel to operate it; and it must interpret correctly the results of this form of inspection. Since electromagnetic crack detection is also specified in the inspection procedure of steel castings, this must also be available and, naturally, where heat treatment is needed, the foundry must be able to produce uniform and consistent results. Two other requirements are necessary for steel, as distinct from light alloy, castings. First: a number of sets of specially cast test bars, to conform with the material specifications for which approval is required, must be submitted to a Government Test House for statistical examination. Second: the foundry must show that it has a full appreciation of the all-important differences between the manufacture of aircraft quality steel castings and the manufacture of ordinary commercial steel castings for general engineering purposes.

Some of the steel castings which have been produced in Canada by the Dominion Foundry and Steel Company of Hamilton for use on the A. V. Roe Canada

(Continued on page 42)

Comparison of two steels

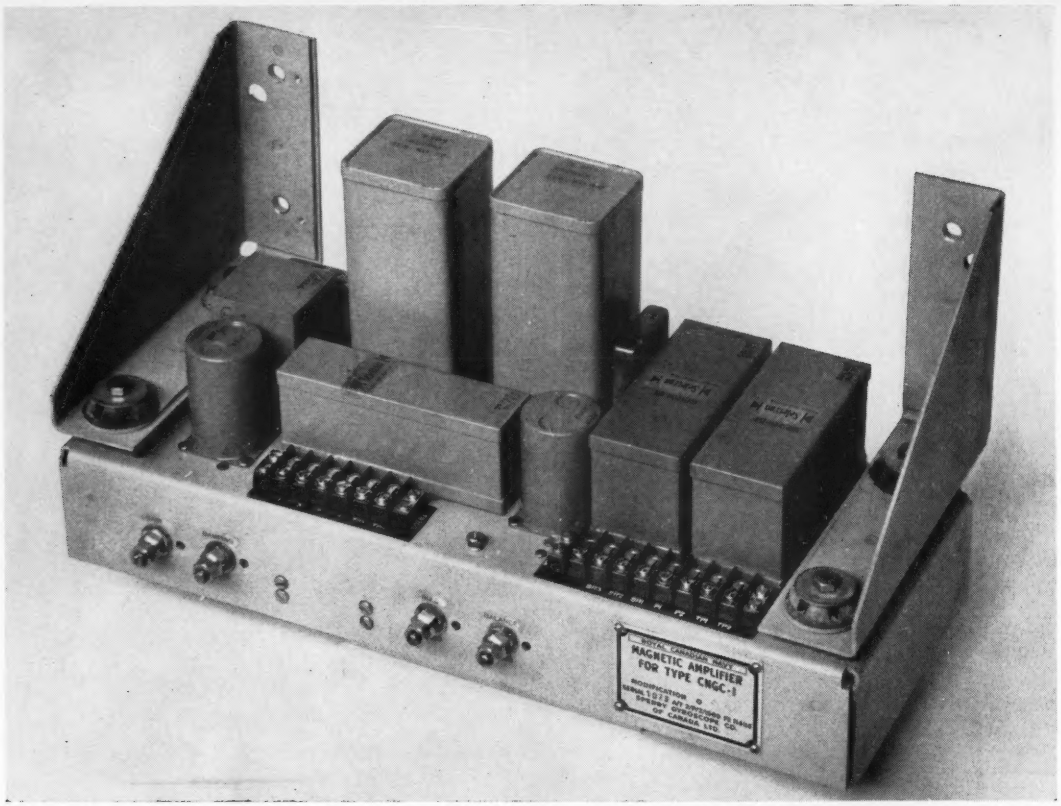
	DTD 666	DTD 705
Ultimate Tensile Strength ksi ..	134 minimum	168 to 184
0.1% Proof Stress ksi	102 minimum	134 minimum
Elongation % ..	12 minimum	7 minimum
Reduction in Area %	30 minimum	14 minimum
Hardness BHN .	269 minimum	340 minimum
Izod Impact ft. lb.	30 minimum	10 minimum

Analysis of two steels

	1% Cr-Ni-Mo	2% Ni-Cr-Mo
Carbon %	0.22 — 0.32	0.22 — 0.32
Silicon %	0.30 — 0.50	0.30 — 0.50
Sulphur %	0.020 maximum	0.020 maximum
Phosphorus %	0.020 maximum	0.020 maximum
Manganese %	0.40 — 0.75	0.50 — 0.80
Nickel %	0.50 — 0.70	1.75 — 2.25
Chromium %	0.90 — 1.20	0.80 — 1.20
Molybdenum %	0.15 — 0.35	0.30 — 0.40

Effect of Ruling Section

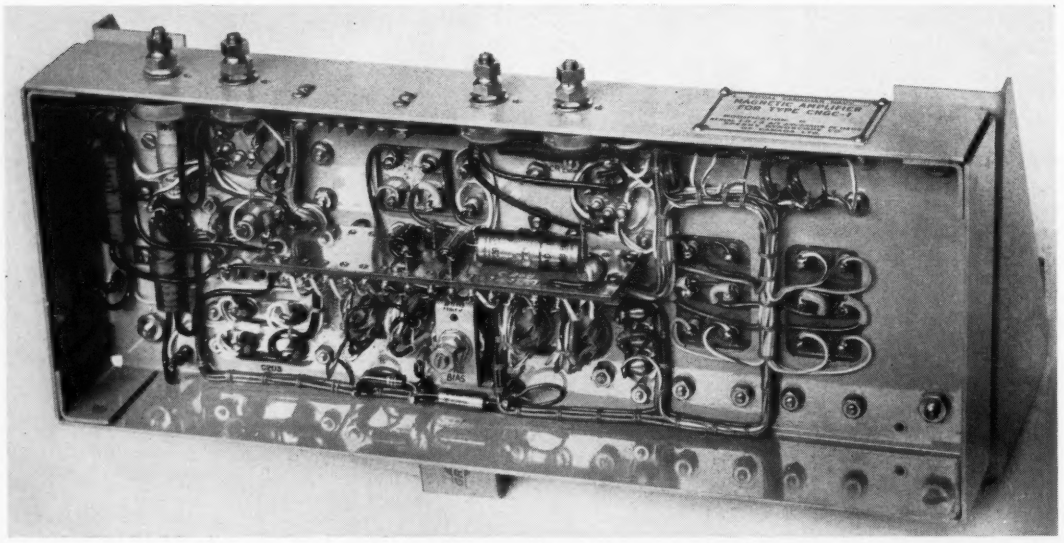
Steel	Nominal UTS (ksi)	Ruling Section (inches)
1% Cr-Ni-Mo	145	2
	170	1¼
2% Ni-Cr-Mo	145	4
	170	3¼
	190	2½



This magnetic amplifier joined the navy. It is a servo amplifier used in a synchro retransmission system.

Magamp Jumps Forward in Industry

Until today, the control field has been dominated by rotating and magnetic type amplifiers. But now the magamp is sweeping ahead, because it does a better job



The underneath of the navy's magnetic amplifier. Without bearings or brushes to wear, it gives long service.

By D. A. G. KELLY, P.Eng.
RYERSON INST. OF TECHNOLOGY

MAGNETIC AMPLIFIERS are sweeping quickly through the control field. Quite a short time ago their work was done by rotating amplifiers (the amplidyne and rototrol) or by electronic amplifiers of the vacuum or gas-tube type. Now the "magamp" is taking over. It is doing so for the simple reason that it does a better job in nearly all controls.

Why is the magamp better than the rotating type? There are several reasons: For instance, it is more reliable; and its response rate is greater; it has a longer life — there are no bearings, brushes or commutators to wear out; it is cheaper to install, because it comes in a sealed dust-proof package needing only to be clamped into a panel; it uses no costly starting equipment; and it has simple circuit stabilizing.

And how does it measure up to the electronic amplifier? It is the same sort of story. The magamp needs much less maintenance (there is a specially big saving on replacement tubes); it is more efficient and so can be worked off signals as small as 50 millivolts from a shunt or thermo-couple; it has no filaments and so needs no warm-up time; it has lower heat dissipation and so can be built in large units; it does not demand d-c supply; it does not damage easily from shocks; its isolation between the signal and output stage is an inductive coupling, which is an excellent feature; and its control circuit is electrically isolated from the output which makes the cascading of magamps easy.

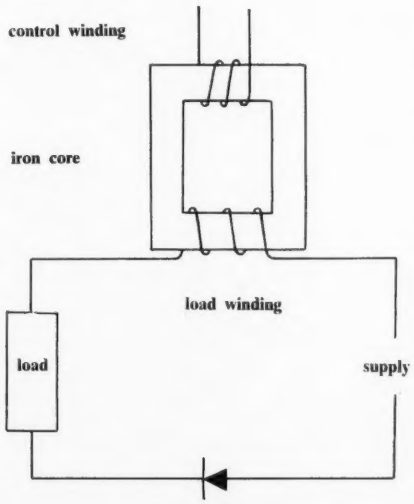
In its simplest form, the magnetic amplifier consists of a rectifier and a self-saturating reactor connected in series. Picture 1 shows the device connected in a simple circuit. Small changes in the control signals cause large changes in the impedance of the self-saturating reactor and so the power delivered to the load is controlled.

This very simple version of the magnetic amplifier is useful as a way of showing the principle but it is not practical for two reasons. The first one: large currents would be induced in the control winding from the currents in the load winding, since the load and control windings are wound on the same iron core, like a transformer. Second: the rectifier would only allow the circuit to pass current every alternate half-cycle. Obviously this is inefficient because the power reaching the load is only half the value it would be if both a-c half-cycles were used. In addition to this, there would be a disastrous loss of efficiency in the response time of the amplifier, for this depends on the frequency of the current passing through it.

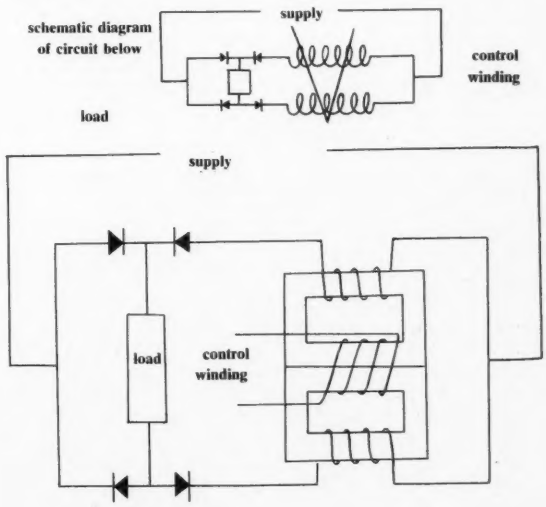
To make the magnetic amplifier a commercial proposition, the simple circuit is modified. Picture 2 shows a magnetic amplifier in which these changes have been made. Instead of a single load coil on one core, the core has three legs. The load coil is divided and half is put on each of the outer legs so that the flux from each coil cancels in the centre leg. Therefore, the control winding on this centre core has no current induced in it from the load winding. Now the first of the difficulties, the transformer action, has been overcome. By dividing the load winding, two rectifiers can easily be included in the circuit to rectify both halves of the alternating current cycle. And so the second objection to the simple circuit has been overcome also.

Magnetic amplifiers may be classed under two headings, depending on whether they give:

1 Small signal amplification, where small signals from thermocouples, photocells and pyrometers are applied to the control windings so that they control large signals to a load. In this case magnetic amplifiers are often connected in cascade to amplify the signal. This cascading is an even simpler operation than when



1. *A magnetic amplifier in its simplest form, a rectifier and reactor in series.*



2. *The simple circuit has to be modified for use. The core becomes three legs, to stop a transformer action.*

electronic tubes are used. The small signal magnetic amplifiers, however, need special design to compensate for voltage and frequency.

2 Large signal amplification where fairly large voltages are used across the control field. An example of this is in voltage regulators where the output voltage of the generator is used in the control winding of a magnetic amplifier to adjust the current in the field of the exciter.

A very popular use of magnetic amplifiers for large signal amplification is to control the output voltage of a direct current generator. Voltage control of d-c generators requires a working knowledge of the closed loop regulating system. Picture 3 shows a block diagram for the closed loop regulating system for a d-c generator, although the generator may be replaced by almost any other device which produces an output signal. The error detector input consists of the output voltage of the d-c generator. This is balanced against a carefully stabilized d-c reference voltage. If the generator and the reference voltages are exactly equal, the error voltage is zero and there is no input to the power controlling device. If the voltage of the generator rises above the reference voltage, lead X becomes positive with respect to lead Y.

There is for this reason a difference between the reference and the input signal. In this case there will be an output from the error detector to the controlling device, and the field current to the generator will be reduced to bring the voltage back to normal. Likewise, if the generator output voltage falls, X becomes negative with respect to Y. A negative signal from the error detector allows the controlling device to increase the field current and bring the voltage back to normal again. The closed-loop system therefore always tries to keep the error voltage as close to zero as possible. The greater the sensitivity of the error detector, the more closely this can be achieved. This system has two great advantages which make it commercially important:

- The voltage output of a large generator can easily be adjusted simply by changing the reference voltage (a very low wattage control).
- The generator will maintain the same voltage regardless of the load current, if the reference voltage is kept constant.

All voltage regulators follow this simple closed loop system whether they be mechanical, electrical or electronic. When a magnetic amplifier is used as a voltage regulator, it performs the function of both the error detector and the field current control. Picture 4 shows a typical circuit of the magnetic amplifier used for voltage regulation. The controlling device consists of the load winding of the magnetic amplifier and the error detector consists of two control fields. One is connected to the reference voltage, which is fed from a full wave rectifier with voltage regulating tubes. The other winding is connected to the armature output so that the signal in this winding depends on the voltage generated. With this arrangement, if the generator voltage falls, the flux in the feed-back field also falls and more current passes through the main windings of the magnetic amplifier. The result is that the generator field gets more current and the armature voltage rises again. The reverse action takes place, of course, if the generator voltage rises.

In the lumber industry the magnetic amplifier is useful in the log-carriage control drive. In lumber mills, logs are cut into planks by being passed back and forth through a circular saw. The log in its forward and backward movement is held in a log carriage pulled to and fro by means of cables attached to each end. These cables are passed over pulleys to a drum drive driven by an electric motor. It is obvious that the faster the log changes its direction once it has gone through the saw, the more timber will be cut and the more efficient the routine will be. A d-c variable voltage drive, similar to the old Ward Leonard system, would do this work up to a point but would soon deteriorate if the operator switched from full forward speed to full reverse speed, without any means of limiting the motor current. Here is work for a magnetic amplifier. It acts as a brain for the motor, by stopping the current from topping a value the motor can handle and so overheating is prevented.

Picture 6 shows a log-carriage drive control unit using a magnetic amplifier in the way just explained. A direct current motor drives the cable drum. Its speed depends on the output from the generator (G) which in turn is governed by the output of a rototrol or amplidyne supplying the field circuit. Three of the control windings in the rototrol or amplidyne are used. One is connected to the generator output so that, if the voltage of the generator is greater or less than is desirable, the rototrol will compensate. The other two windings are connected to the magnetic amplifier and allow the motor to be operated in a forward or reverse direction at different speeds. The output of the magnetic amplifier in turn depends on the settings of the operator's switch. It is also controlled by current feedback from the motor so that if the motor tries to grab more current than it can handle, a message is transmitted to the magnetic amplifier. This immediately reduces the generator output by limiting the current in the rototrol field.

The closed loop system always tries to keep the error voltage close to zero

Another interesting use of magnetic amplifiers is in a paper mill control drive. Paper is made by a continuous process from the pulp stage to the actual rolling of the paper onto a drum at a fixed linear speed. The drum is driven at its centre by an electric motor and must rotate at a speed producing an even tension on the paper. A constant-speed motor would not be satisfactory, because as the diameter of the roll builds up with paper, the speed of the motor has to slow down, to keep the tension the same. A satisfactory motor must have its power input held constant. This is done by fixing the voltage applied to the armature and by using a regulating device to ensure that the excitation does not change.

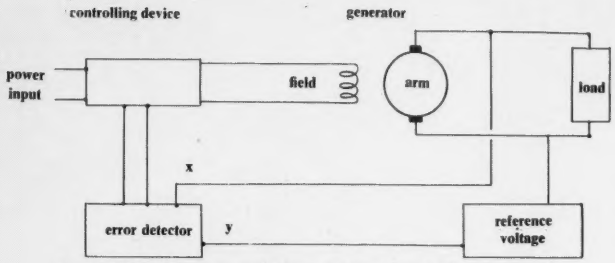
The magnetic amplifier is admirably suited for this job. The circuit is shown in picture 5. See that the magnetic amplifier has three control windings. One is energized by a reference signal, another by a signal depending on the armature current and the third by a feedback voltage depending on the current in the motor field. The armature current signal and the reference balance one another. Any out-of-balance signals are

amplified in the magnetic amplifier and passed on to the field circuit of the motor, which adjusts to hold the armature current constant. The signal depending on armature current is got from the voltage drop across a resistance X. Resistor Y controls the maximum working speed of the motor by changing the current that can flow through the field of the motor. Resistor Z controls the reference voltage on which the power output of the armature depends. To speed up the motor, reduce the resistance Y and to increase the motor torque, increase the resistance Z. For any given setting of Z, the torque on the paper will be constant, regardless of the reel diameter as most readers will very quickly see.

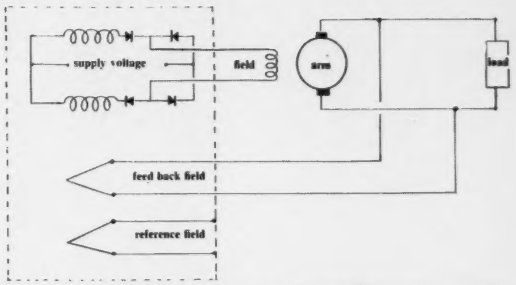
In this article, only three useful applications of magnetic amplifiers have been discussed. There are many others; in fact the U. S. Bureau of Ships lists twenty-six in its publication, "Magnetic Amplifiers." But enough has been said to show that another tool is now available to help engineers and designers. With it, they can produce better and more reliable amplifiers and control equipment than has been possible before.

The magnetic amplifier is not yet expected to replace all older, more perfected, methods; but soon it will — soon all electronic tubes and rotating amplifiers will give way to magamps and transistors. The movement toward them is well under way. ★

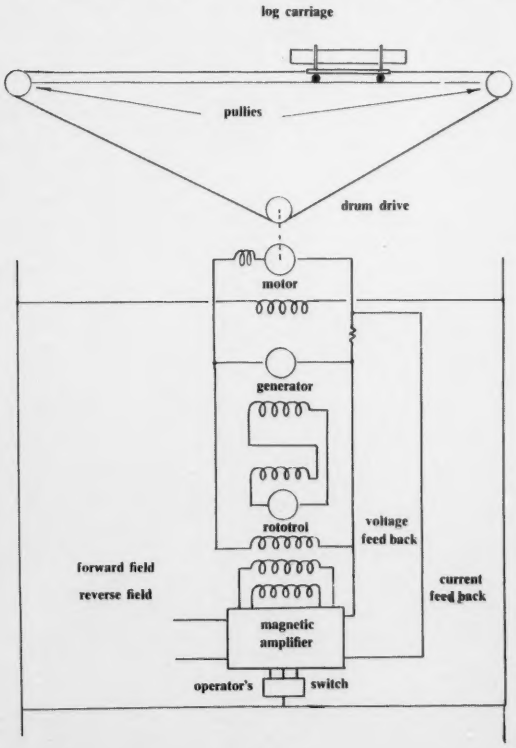
These four typical circuits show magnetic amplifiers in use as motor controls



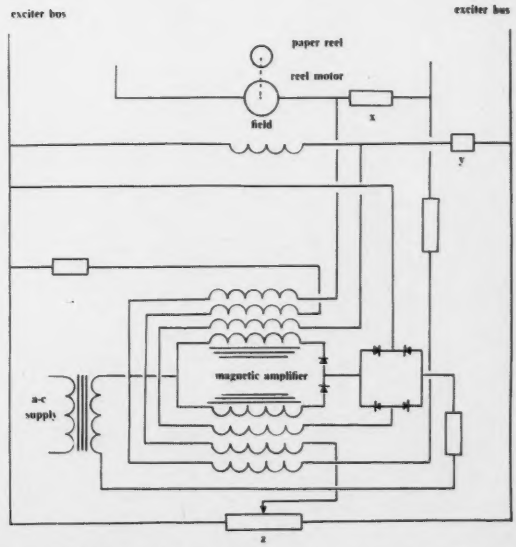
3. *A closed loop regulating system for a d-c generator — or for any other devices producing output signals.*



4. *Voltage regulation by a typical magamp circuit. The two control fields and load winding watch for errors.*



5. *A log carriage control. It acts as a brain and cuts current before there is danger of overheating.*



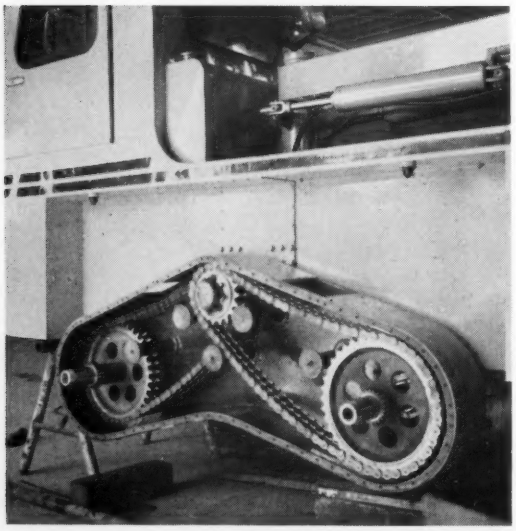
6. *This circuit has three control windings. They get energy from reference signal, armature and feedback.*

The North King transporter pictured during one of its torture-trials. It survived and goes now to production.

Canadian Transporter Ends its Trials

A new heavy-weight truck with many unique design features has come from a Calgary shop to start traveling Canada's rougher country

By RON ANDERSON



The huge transporter "walks" over bumps. A walking-beam design lets drive wheels rise and fall freely.

FIELD TESTS of a new type of off-highway transporter designed specially for use in Canada's rugged north country have ended. The vehicle (the North King Universal Transporter) has been judged a success and it goes now to assembly line production in Calgary. Twenty prototypes were made by North King Equipment (Canada) Ltd., during the long, careful development program.

Among the mechanical features on the transporter which make it well fitted for work in rough country are: full articulation; a unique power-steering mechanism; increased track area (and so greater payload); rubber-tired wheels which can wear tracks over them for better traction and "floating" in very soft conditions; 30 in. unobstructed clearance under the body; and flexible design which allows a variety of mounted equipment and bodies to be carried.

L. L. Cahan, manager of the firm, says the North King will perform in muskeg, mud, snow, rough and broken terrain, and even in water. Its body is watertight, enabling it to float—propulsion in water coming from rotation of the tracks. The vehicle's ability to travel through muskeg impassable for other transporters is a result of the low weight per sq in. This allows it to carry payloads up to 6,000 lbs through muskeg.

The walking beam action lets the transporter travel across extremely rough ground without "pitching" the cab; and the large twin-engine, 8-wheel-drive model, with tractor and trailer component independently powered, has proved capable of climbing a slope of 53 per cent with a 12,000-lb payload—from a standing start.

While manganese steel tracks, 24 inches wide and with a total ground contact area of over 8,000 square inches, are provided for use in very soft conditions, it is estimated that 90% of the vehicle's work can be done on the rubber tired wheels. Chains can also be used to give the wheels additional traction. The vehicle may be driven on the highway between locations.

Stimulus for development of the North King was provided when United Trailer Co., parent firm of North King Equipment, was asked by Imperial Oil to manu-

facture two specially designed track vehicles for muskeg country. With the search for oil in the western provinces becoming keener, attention has recently been focused on the 400,000 sq miles of country in Northern Alberta and the northwest territories thought rich in oil. Much of the country is covered with muskeg, wandering streams and bush, and oil firms have found that for seven and a half months of each year the country is virtually inaccessible. Exploration crews have been able to move freely throughout the area only in the winter, when the ground is frozen.

Manufacture of the vehicles for Imperial Oil brought the Calgary group into contact with the problems faced by oil crews operating in the north country. When the vehicles had been completed, W. Bruce Nodwell (an executive director of North King Equipment) became sure that the answer to the transportation problem in the north lay, not in a specialized vehicle at all, but in a universal transporter capable of working under all conditions. This led him to design the North King.

First step was construction of a pilot model which, under rigorous tests, proved that the basic principles were sound. Later a production model was completed and spent several months in the field while bugs were watched for and overcome. During these tests the transporter showed itself capable of carrying equipment never before possible in rugged and soft areas.

The load-carrying capacity of vehicles used in soft country is limited by the ground contact area, which in turn is limited by the size of the vehicle. A vehicle width greater than eight feet is not possible because of highway regulations. Greater track area may be gained by increasing the length of the vehicle, but it is unwieldy and difficult to turn when the length is too great. It is this that has been the biggest difficulty found in designing off-highway transport vehicles.

In designing the North King, the manufacturers solved the problem by breaking the vehicle in half and providing full articulation at the "hinge." The result is a tractor component and a trailer component integral with one another.

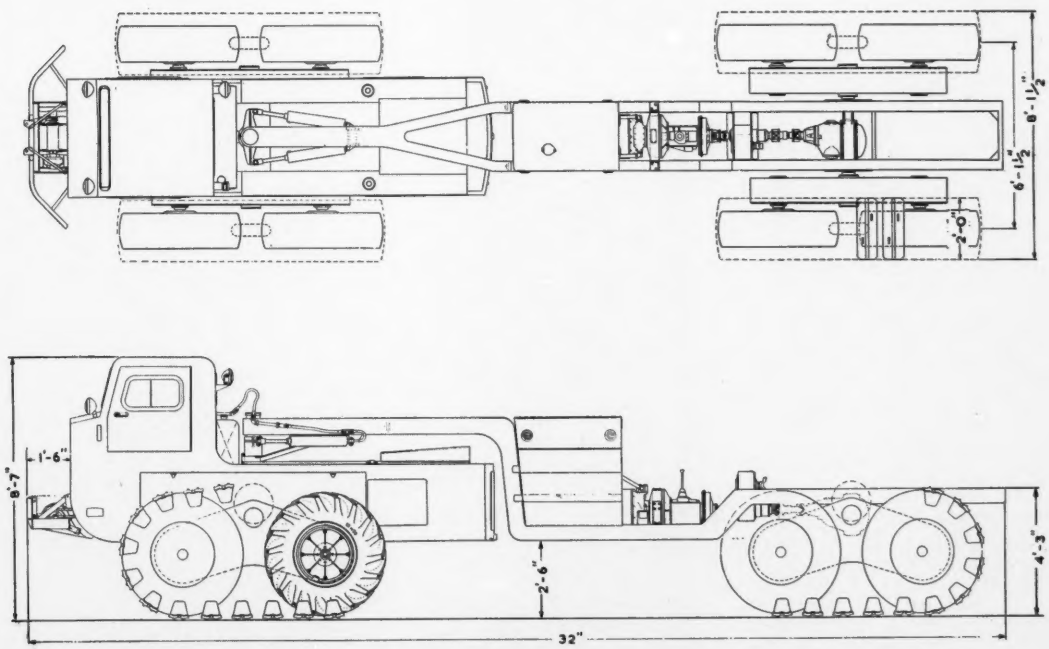
This feature allows the use of hydraulic ram steering. A ram is mounted on each rise of the bar connecting the trailer to the tractor section; the turn is made when the cylinders push against a fixed vertical column in turns up to 72 deg, while still allowing full power to both tracks. Full turn follows a movement of the control wheel of only 2 in. in either direction.

The wheels on either side of each section of the vehicle are mounted on walking beams, acting independently of one another, and allowing the wheels free play in following the contour of the ground. This feature, coupled with the hinging action in the lateral plane between the two components, enables the vehicle to travel over very rough and uneven country without any torque being transmitted to the basic frame — unlike most rigid-frame vehicles.

The first model of the North King was a single-engine transporter. This unit, which is still the standard model, is powered by a choice of industrial engines of different power ratings, and by transmissions of varying gear ratio. Also available are automatic transmissions and torque converters. The differential is matched to the other power components, and is modified to suit the width of the vehicle by shortening the tubes. Final drive is accomplished by replacing a standard truck hub with a double-drive sprocket enclosed in the watertight walking beam. Each of the four driving wheels is independently driven by duplex roller chains.

A newer and larger model of the North King is a twin-engined unit, with a second power plant in-

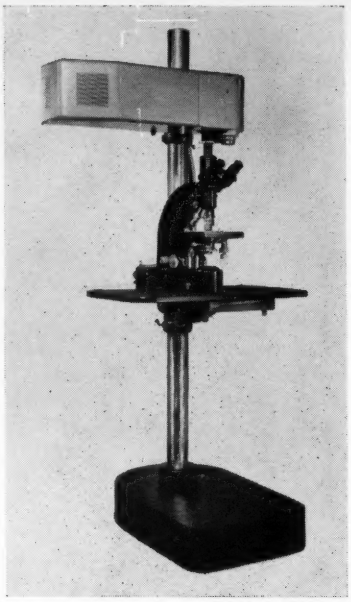
(Continued on page 50)



If 8-wheel drive is needed, model ET carries a second engine in its trailer to drive rear wheels.

Research has new electronic color microscope

Research finds a new way to study tiny objects in color



The new electronic color microscope by CBS which gives the brightest image ever.

ELECTRONICS HAVE BEEN brought to the laboratory microscope to give research a new, better way of studying very small objects in natural color.

CBS Laboratories* are the inventors. The components in the system include a standard type microscope, color camera, camera control console, color monitors and color projectors. From this electronic assembly come brighter images than can be got from older optical methods—yet the amount of light needed at the specimen is much less. This is an important step forward; ordinary optical micro-projectors (if they are to throw large, bright color images) need so much light on the specimens that many live ones and some fixed slides are destroyed.

The new electronic microscope means that these specimens can now be enlarged and viewed by large groups for the first time. And the enlargements show sharp detail, faithful colors and brightness.

A color camera is mounted on a laboratory microscope (see picture). The optics are adjusted to focus the real field through the color drum segments onto the face of the single image orthicon pickup tube.

The CBS field sequential system is used with a 24 cps color frame repetition rate. The horizontal scanning frequency is 29,160 cps, and the vertical frequency is 144 cps interlaced 2:1. Aperture correction and crispening circuits are employed which greatly enhance the subjective sharpness of the viewed images.

The image from the compound microscope normally viewed by the eye is, in the color microscope, formed at the photo cathode of the image orthicon. This image, with a diagonal of 1.6 in. is amplified electronically in brightness and is magnified in size to a diagonal of approximately 11.5 in. on the small monitor, 18.5 in. on the large monitor, and 83 in. on the large screen projector, resulting in image size magnification of 7, 12, and 52 respectively. So, using a 2mm objective and a 10X ocular, the over-all magnification on the large screen can be 90 by 10 by 52, which is 46,800.

In a typical use the field of view through the over-all color microscope is adjusted to be the same as that seen directly by the eye through a 10X ocular. With this arrangement the over-all magnification is:

Object	Small Monitor	Large Monitor	Screen Projector
16mm	305	445	2000
8mm	610	890	4000
4mm	1100	1600	7200
2mm	2200	3200	14400

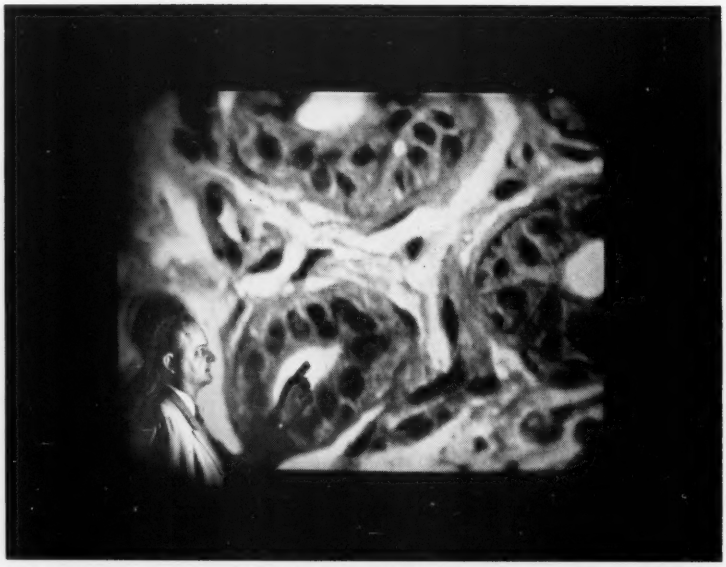
The resolution is of course not greater than would come from the microscope alone but the subjective sharpness in increased through the use of crispening the aperture circuits.

The color microscope system gives results much like those from a combination color photograph and microscope; but the electronic technique is instantaneous and does away with film processes. Moreover, colors can be instantaneously adjusted to give sharp color contrasts—and so on. Besides all this the video signal can be transmitted instantaneously by cable or microwave for multiple viewing at distant points.

The electron color microscope is important to education. Outstanding teachers can lecture with demonstrations to large audiences both in the classroom and at great distances.

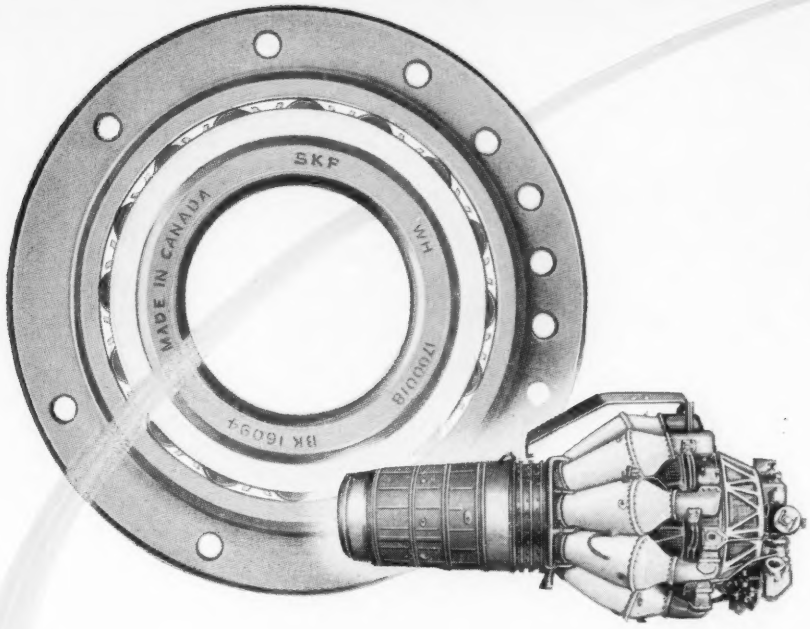
Consulting can be done without the presence of the specialist. This might be especially important during a national emergency when it would be desirable to locate key medical men in remote areas.

In addition to remote viewing, the electronic microscope can be arranged for remote optical adjustments and slide changes. This makes possible the study of specimens exposed to radiation. ★



Living cancer cells magnified (in color) 15,000 times by the new microscope.

*The laboratories were helped by Bausch and Lomb of E. Leitz Inc., while the microscope was being designed.



The Rolls-Royce Nene-10
power plant for the T-33 Jet Trainer.

Another great Canadian-built engine
completely equipped with
precision ball and roller bearings
manufactured by
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Expedition

on their magnificent

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We are proud to have supplied the Expedition with its Oxygen Breathing Equipment, both Open and Closed Circuit.

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YEOVIL ENGLAND

NORMALAIR (CANADA) LTD.

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Precision Steel Castings

(Continued from page 33)

CF-100 all-weather interceptor fighter are interesting.

It is a requirement that aircraft components (or materials from which they are made) must be produced on this continent; as a result, steel castings of this type could not be imported from their source in England. So attempts were made to interest reputable steel foundries in Ontario in the production of aircraft castings. The challenge was accepted by the Dominion Foundry and Steel Company at Hamilton, who were quick to appreciate that their knowledge and experience with general engineering castings, although useful, would not be sufficient to allow them, on their own, to tackle aircraft steel castings, and that much time would be required in which to develop the special techniques of the process. They very wisely contacted David Brown Foundries from whom they obtained much valuable information and "know-how," which included the sending of key metallurgical and foundry personnel from Hamilton to Sheffield. This saved a lot of time and made it possible for production castings to be delivered for the CF-100 in one year from the start of operations. This, of course, included the winning of approval from the RCAF.

What type of steel is used?

It may be asked, "what type of steel is used for these castings?" The answer is difficult because of the variations which the founder is allowed to make, by specification (and which he obviously must make) in his analysis, if he is to succeed in meeting minimum specified mechanical properties. This is because the shape, mass and wall thickness of components are so variable that they will respond differently to heat treatment. Very wisely, those who drew up the British and American specifications steered clear of any attempt to regulate this part of the founder's task except that, especially in the British specification, the undesirable elements, sulphur and phosphorus are limited to 0.020% and 0.025% respectively.

It is interesting to record that analyses of heats made by Dominion Foundry are no greater than 0.015% for both elements.

The analyses of two steels which have been widely used since 1945 (table 3) are interesting because they show comparatively normal alloy contents, the leaner being a nickel-bearing version of 4130. The choice between the two compositions is affected by several factors, not the least of which is the ruling section of the part. Table 4 indicates this relationship.

The choice of which alloy and which mechanical properties are selected depends almost entirely on the functional role of the part. The high ductility and good impact properties of DTD 666 make that alloy very attractive where medium tensile strength is needed under conditions of high shock loads. When shock loads are not in evidence but high tensile strength is required, DTD 705 is the more attractive; if castings are made to the 1C classification, the weight penalty by using castings instead of forgings is practically nil.

Consider now the casting of DTD 666 (see picture) as it comes from the foundry. Areas which will later be machined are rough machined at the foundry. All

(Continued on page 52)

Stanley had a metal problem...

Anaconda had the answer...

"Formbrite"

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MANUFACTURING COMPANY
LIMITED

MAKERS OF NAMEPLATES • FOIL LABELS • NAVIGATION COMPUTERS • PLASTIC AND OTHER SPECIALTIES
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April 26, 1955

Anaconda American Brass Ltd.
New Toronto,
Toronto, 14, Ont.

Attention: Mr. C. Farrow

Gentlemen:

We wish to thank you for bringing to our attention Strip Formbrite Brass used in place of your regular yellow etching brass.

Besides being cheaper the formbrite polishes up a lot faster than the regular brass with less trouble, thereby giving our firm double saving, in price and labour.

Please convey to all concerned our sincere thanks for bringing this material to our attention.

With kindest regards,

Yours very truly,

STANLEY MANUFACTURING COMPANY LIMITED

J. L. Best

J. L. Best:fp

Purchasing Agent.

The specialized knowledge and experience of Anaconda's complete Technical Department is at your service. If you have a metal problem consult Anaconda American Brass Limited—Main Office and Plant: New Toronto, Ontario; Montreal Office: 939 Dominion Square Building.

ANACONDA

***FIRST* in Canada for Copper, Brass and Bronze**

New products & materials

New items which can help you on the job

WIRE THREAD INSERTS have enabled the English firm of **Benton & Stone** to reduce the cost and weight of their **aluminum "Enot" air cylinder heads** by discontinuing the use of an expensive brass union.

Because of the pressures involved and the possibility of failure of threads tapped in aluminum, the original design called for a brass union screwed into coarse threads in the head. The union was tapped with a ¾-24 thread suitable for a ½ in. solderless joint to receive the outlet connection.

Using the inserting tool

Inserts are screwed into threads in the aluminum with a Heli-Coil inserting tool to provide permanent, smooth, wear-resistant, strong threads of stainless steel. (200)

• • •

A NEW INSTRUMENT for the nondestructive **testing of concrete** is the Soniscope handled by the **McPhar Engineering Co. of Canada, Limited.** It provides a reliable, low cost means of examination previously made only by slow and costly core removal procedure. Engineers concerned with construction, maintenance or appraisal of concrete structures will welcome this new tool because of the quick and direct results it gives in both field or laboratory.

It was developed by the Hydro-Electric Power Commission of Ontario to examine its dams and other hydraulic works and for laboratory studies. It is now used for non-destructive testing of concrete bridges, foundations, walls, buildings, slabs and other construction.

It transmits impulses of high frequency sound and measures the time of their transmission. The received signals are amplified and displayed on a cathode ray tube in the display unit. The displacement of the received pulse from the origin on the cathode ray tube represents the time of transmission. If the distance between the transmitter and receiver can be measured, the velocity of transmission may be calculated.

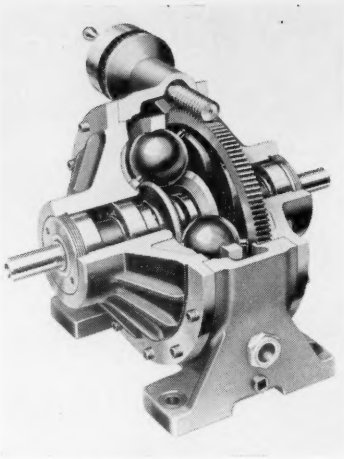
The velocity varies with the condition of the concrete and, for a given structure, this variation is normally in direct proportion to the quality of the concrete. A crack or void in the direct path of the transmission increases the path length or stops transmission entirely. From this the presence and extent of these faults can usually be found. (201)

• • •

THE ROLLING ACTION of a series of balls, to provide infinite speed variation from one third to 3 times the input speed, or a total range of 9:1, is used in the **Cleveland Speed Variator.** This simple, compact drive is designed to operate at its full power rating over the entire range of output speeds. It is based on the patented design of a Swiss engineer, Jean E. Kopp.

Power is transmitted from the input shaft to the input drive disc, which is in pressure contact with the balls. A similar contact between the drive balls and the output drive disc transmits power to the output shaft. The drive discs are not directly connected to the drive shafts, but are driven through roller and cam pressure mechanisms, which cause the drive disc to press against the balls with a force proportional to the applied torque. This design gives high operating efficiency and maximum overload protection. The balls are not retained radially by their axles, but instead are positioned both radially and axially by the three points of contact provided by the free-floating outer ring and the two drive discs.

The relative speeds of the two shafts are adjusted through the 9:1 range by the angular positioning of the axles about which the balls rotate. With the ball axles parallel to the drive shafts, the speed ratio is 1:1, but when the axles can be uniformly tilted in either direction to a common point of intersection so that the effective rolling radii of the balls with the drive disc can have a ratio as high as 3:1. This angular adjustment is made by changing the position of the slotted plate through which the ball axles project. Close control of the speed adjusting mechanism is obtained by a worm and gear, which can be operated either manually or by a variety of remote control devices. The output speed curve is a close approximation to a geometric progression; one turn of the adjusting wheel produces about a 7½% speed change from the previous setting.



Rolling action of balls

The speed variator is built in sizes ranging from ½ hp to a maximum of 10 hp. It is inherently smooth and quiet in operation, and its coaxial input and output shafts rotate in the same direction. Simplicity of construction permits close speed regulation without complicated linkage and without drift. The drive is totally enclosed with all its mechanisms running in oil. (202)

• • •

HELPING TO PIN-POINT underground oil traps and cut down the number of dry wildcat wells is one of the first assignments for the Datatron **electronic digital computer** installed this month at Magnolia Petroleum's Field Research Laboratores in Dallas, Texas.

Manufactured by **ElectroData Corporation,** the computer is stated to be the largest robot "brain" placed with any U. S. oil company.

According to Dr. D. H. Clewell, director of the Magnolia research group, the new machine will supply high-speed answers to a variety of complex questions in oil exploration and research all over the globe.

One such problem is to boost subsurface mapping accuracy and make easier the precise location of oil traps.

Continued on page 46

FIBERGLAS*

often the difference between making or breaking an idea

The great forces and stresses, extreme contrasts and demands placed on new structures and new products means that thermal insulation materials play a very vital part in the success of many ventures.

For years Fiberglas has made Thermal Insulation Materials a large portion of their business. From the wide range of materials they produce for the aeronautic, automotive, marine, railway and transport industries, residential and commercial building, stoves and refrigerators, cold storage plants and warehouses, pipe and boiler insulations, products for sound control, and other materials for a host of other industries you're bound to find the material best suited for your specific plans.

Another feature to consider when you buy Fiberglas is that BAKELITE Resins are used in many Fiberglas products . . . a good point to remember when you're dealing in Thermal or Acoustical Insulation Materials.

*T.M. Reg'd. Fiberglas Canada Limited.

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- Polyesters

New Products & Materials *continued*

Because of its tremendous capacity for digesting masses of numbers, it will be possible to correlate data from various well logging methods with that from surface seismographs in a matter of minutes, where days were needed before.

As many as 2,000 pieces of information may be fed into the machine during analysis of just one set of seismograph records, to fill gaps which have always plagued other methods.

The $169,000 Datatron with accessories will add or subtract 500 numbers of ten digits each in one second; it will make 120 muliplications and 85 divisions also in the same length of time. Numbers are read into a magnetic drum "memory" by means of coded punched cards, punched tape or magnetic tape. This memory can store over 4,000 computer words (ten-digit numbers). After its mathematical operation, solutions are produced on a special automatic typewriter or any of several reading and recording devices.

Future jobs for the machine include **1** determining whether pressure, volume, temperature and fluid viscosity relationships can be locked into a set of useful inter-relations; **2** analyzing material quality to aid in designing production tools; **3** assessing equipment performance; **4** calculating statistical production information, such as estimated crude oil runs; **5** studying the relationships between grain size, porosity, composition, and so on of oil sand grains; and **6** predicting future behavior of oil reservoirs. (203)

• • •

A PATENTED DESIGN for the **transmission of power,** known as the Gilmer Timing Belt (**Dominion Rubber Co., Ltd.**) gives a completely positive drive that does not depend on frictional grip for the transmission of power. When the power source delivers 1,800 rpm, the belt delivers exactly 1,800 rpm. There is no slip, creep or speed variation.

The drive element consists of a helically-wound steel cable which gives the belt enormous tensile strength. The steel cable eliminates the problem of stretch. As the pulling element is embedded in neoprene, the belt is highly oil- and heat-resistant.

No initial tension is required for most applications, and this permits operation on fixed centres. Since there is no stretch, no tensioning of the belt is necessary.

The structure is so light and so strong that centrifugal effect is reduced, permitting belt speeds in excess of 15,000 fpm. It is so flexible that it runs over pulley diameters as small as ½ in. Horsepower loss due to flexing is reduced to a minimum. Strength is so concentrated that space saving is an important factor. Drives involving heavy duty and shock loads find the tensile strength of these belts especially suitable.

It functions on drives where idlers are required, and horsepower can be taken from the back of the belt.

The teeth enter and leave the grooves in a rolling manner. This action permits the engagement and disengagement of the teeth with negligible friction. The unit is recommended for synchronization, for power transmission or for use as a functional machine part. (204)

• • •

A NEW LINE of conventional and completely self-protecting **distribution transformers** is announced by **Canadian Westinghouse Company's** Industrial Products Division.

Available in ratings from 3 to 200 kva conventional and 100 kva csp, the new line has improved core and coil designs which, it is claimed, will mean peak performance with lower losses and higher efficiency. These new designs are also smaller and lighter than for most ratings of former types.

In transformers up to 50 kva, new type "C" cores, built from cold-rolled, grain-oriented, high permeability silicon Hipersil steel are used. Cores are wound from a continuous strip, annealed and bonded into a solid unit which is later cut into two C-shaped sections and banded together. Only two bolting arrangements are required for the entire core and coil assembly.

In ratings above 50 kva, the newly-designed cores are built from stacked laminations of the same Hipersil steel, cut to 45% angles to maintain the unidirectional flux path.

A design feature that makes maintenance easier is the lift-and-lock arrangement of the new transformer covers. These are designed to hinge at a combined lifting lug and lock-down device immediately above the low voltage bushing so that covers can now be removed or locked securely in the open position. A permanent tap changer diagram has been placed inside each cover.

New type high voltage bushings are interchangeable between all voltage ratings. A hand clamping knob is used for high voltage connections to do away with the need for wrenches or other tools. Both high and low voltage bushings have been designed with sheds for maximum creepage distance. Terminals are arranged for easy connection.

The new distribution transformers are available in ratings up to 50 kva. (205)

Letters

Readers' viewpoints . . .

● I should like to say that I am encouraged to find a Canadian engineering publication such as yours, that is not scared to death of a little display of mathematics. It seems that so many of our publications are so crammed full of articles on professional ethics, professional salaries and so on that there is little space left for the treatment of real engineering subjects. DESIGN ENGINEERING so far is filling this need.

T. W. SPAETGENS,
Vibration Engineer
Vancouver

● Mr. Conklin is correct when he says (DESIGN ENGINEERING, June) that two thirds of the NIDC awards go to products superior in appearance, for this is one of the basic motives behind the design awards—to improve the appearance of Canadian products.

The other main aim is to give recognition to Canadian talent in design. If we encourage our youngest profession, that of industrial designer, by giving its members occasional acclaim for work well done, then perhaps they will someday become as well known in industry as their colleagues in the U. S.

Mr. Conklin, of course, is also right, in thinking that one third of the products are not necessarily up to the level of the rest; however, he is definitely wrong in calling them substandard. No product can compete for the design awards until it has first passed rigid examination by the preliminary rating committee which meets once a month and which is also the selection committee for the Canadian design index. A product must be able to stand up to the following questions before it can pass this preliminary examination (manufacturers are given the list of questions so that they can understand the standards involved):

1 Is the form suitable to the function of the object?

2 Is there a harmonious relationship of all parts?

3 Is the design as simple as it can be in relation to the manufacturing process employed and materials used?

4 Is there any unnecessary or meaningless ornament?

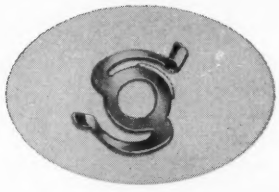
5 Is the use of texture and color both honest and logical in relation to material used and the function of the object?

6 Is it mechanically efficient?

7 Is the material used a suitable one with regard to function and manufac-

Q: How can you build greater reliability into your electrical spring parts?

A: With NORANDA PHOSPHOR BRONZE◆



Parts made from Noranda Phosphor Bronze (Alloys 35 and 36) retain their resiliency and high flexural strength year after year. The inherent characteristics of these rugged Noranda alloys also make them corrosion and wear resistant. And their excellent electrical properties increase the operating efficiency of parts.

For technical help in specifying the right alloy for electrical parts and prompt service on your metal needs, call your nearest Noranda Sales Office.

◆ *One of the many Noranda Metals with High I.Q. (Inner Quality) for economical fabrication and improved products.*

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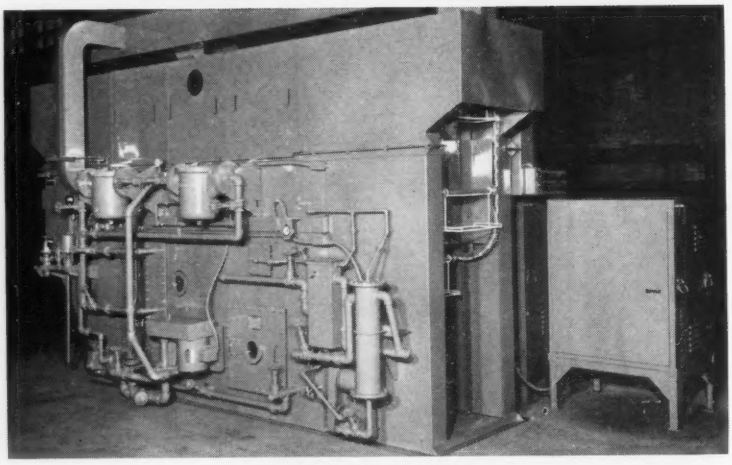
Mills at Montreal East

Sales Offices: Montreal, Toronto, Windsor, Edmonton, Vancouver

Noranda is the Reliable Source for all Brass Mill Products

"ULTRASONIC"
PRECISION DEGREASING

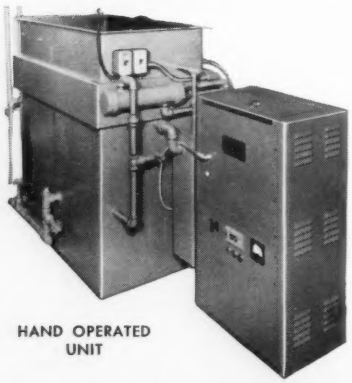


CONVEYORIZED UNIT

WHAT IT DOES . . . An Ultrasonic Degreaser removes dirt, smut, buffing and lapping compounds from deep crevices, holes and recesses of intricate parts.

HOW IT WORKS . . . An Ultrasonic Degreaser consists essentially of a properly designed Royalene (trichlorethylene) Degreaser, an ultra high frequency generator and a set of transducers whereby the high frequency power is transformed into ultrasonic sound waves so beamed at the work as to literally explode off the solid dirt.

WHERE IT IS USED . . . An Ultrasonic Degreaser is used wherever tough military or industrial standards of cleanliness must be met as in the cleaning of refrigerator compressors, precision aircraft and engine parts, automatic transmission components, outboard motors, jewellery, ball and roller bearings, etc.



HAND OPERATED UNIT

MODELS AVAILABLE

Units can be adapted to your present degreasing equipment or complete hand operated or conveyorized Ultrasonic Degreasers can be installed.

A demonstration unit in our Toronto plant is at your service.

CHvW

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Head Office: 2 Silver Avenue, Toronto 3

PLANTS AT TORONTO, ETOBICOKE, WINDSOR

Sales offices and warehouse — Montreal

Resident Representatives: Chatham, Hamilton, Kitchener

turing processes it should go through?

8 Is it firmly constructed and durable and safe?

9 Has ease of maintenance and repair been considered?

Even granted this initial safeguard, the design award judges are sometimes confronted with a special problem since in certain categories of production in Canada, not many new designers are put on the market each year. Then the products submitted to NIDC, while coming up to basic standards, may not show much improvement over existing norms. Yet, in order not to discourage manufacturers from competing (and they might well be discouraged if no awards were given in these categories) the policy to date of the council is to follow literally the phrasing of the awards: "for a product outstanding in design in its category." This means that sometimes, when the product is not equal to the best of international standards but is yet definitely oustanding in its own field, it has received an award.

As the profession of industrial design flourishes in Canada, more competition, naturally, will ensue—and judging of the awards will become progressively more strict. This is the course envisaged by the council.

As for Mr. Conklin's suggestion: "to allow the separate approbation of good but not exceptional work"—this is already provided by the Canadian design index which is an NIDC publication listing (and illustrating) all Canadian products which reach a given standard of design but which may not have won design awards.

Any organization must walk before it can run and, as much as the NIDC work to date has had to be done by means of volunteer assistance given freely by prominent manufacturers, engineers, designers and educationists who sit on the judging and rating panel, it has not been possible with limited staff to give as much detailed criticism to manufacturers as might have been wished; however, the staff has now been increased and the council recently agreed that, in future, manufacturers requesting such service would be given constructive comments on the design of their products.

D. W. BUCHANAN,
Secretary, NIDC.

Ottawa.

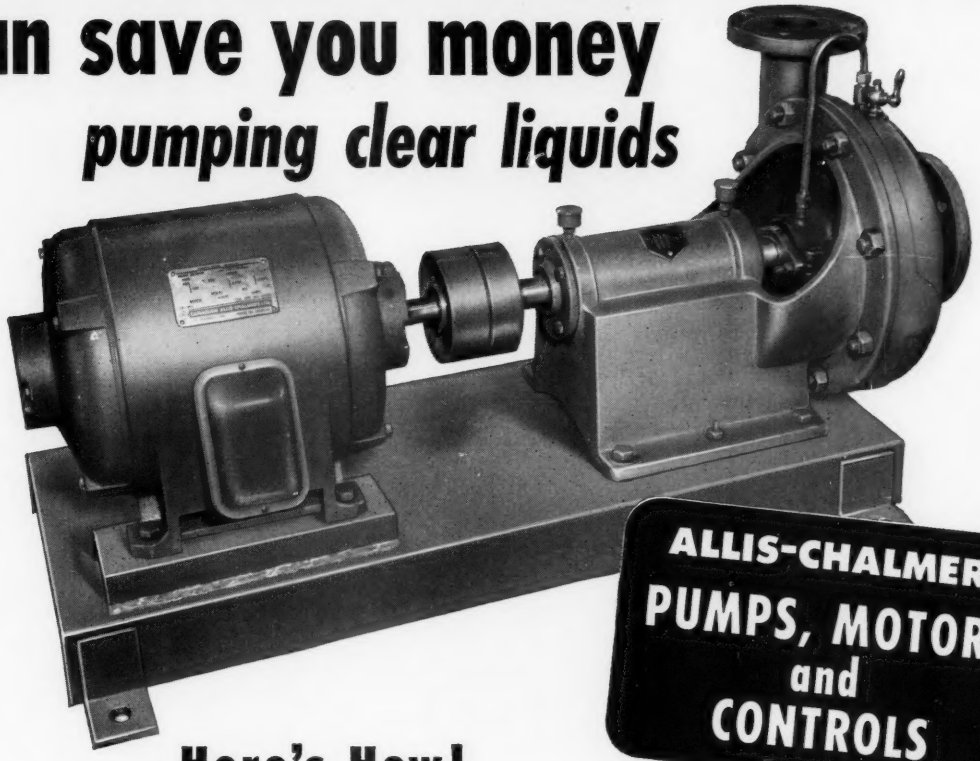
● Please send one copy of your magazine DESIGN ENGINEERING addressed to my attention.

This publication has been highly recommended as a possible source of valuable information which could be used in the type of work performed by this department.

S. R. SULESKI,
RCA Victor, TV Division

New Jersey.

This "PACKAGE DEAL" can save you money *pumping clear liquids*



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It's faster, easier when pump, motor and control are purchased from one company. All components are co-ordinated for you. Parts match up properly. Delivery is quicker.

2. *Cut Installation Costs*

Parts fit together easily because they are designed and built to be used together . . . to meet a single set of standards.

3. *Simplify Service*

When the complete unit is obtained from one source, responsibility for performance rests with only one company, an important advantage in time and service.

4. *Boost Pumping Efficiency*

With pump selected to meet your exact needs, and motor and control engineered to meet the requirements of that particular pump, mechanical and electrical factors can be matched for maximum efficiency and economy.

RELIABLE PERFORMANCE — LOW OPERATING COSTS

Allis-Chalmers Type SSB Pumps are made to handle a wide range of liquids encountered in chemical, petro-chemical, mining, pulp and paper and other industries. They require a minimum of maintenance, provide high volume, and will suit practically any type of installation. Liquid end is self-contained and can be supplied in stainless steel, bronze, Ni-Resist, Monel Metal, nickel or other special material when used for pumping clear corrosive liquids. High degree of parts interchangeability. Wide range of sizes to handle from 10 to 3,000 gpm.

For complete information contact your nearest CA-C Sales Office or write direct to Canadian Allis-Chalmers Ltd., P.O. Box 37, Montreal, Que.

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CANADIAN ALLIS-CHALMERS

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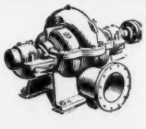
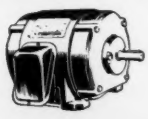
ONE RESPONSIBILITY



PUMPS



MOTORS

CONTROLS

Transporter

(Continued from page 39)

stalled in the trailer section to provide full eight-wheel drive. This model is ordinarily powered by one or two six-cylinder ohv engines, with a displacement of 223 cu in. and developing 82 bhp at 2,800 rpm. Larger models are equipped with one or two V8, ohv engines with a displacement of 317 cu in. and developing 110 bhp at 2,800 rpm. All new models have a banjo-type, heavy duty differential with a ratio of 9.97 to 1.

Model E, with a six-cylinder motor, on natural soil and with an 8,000-lb load, has a drawbar pull of 8,005 lb. Model ET, with two six-cylinder engines, has a rated drawbar pull of 14,822 lb. The largest model, the FT, powered by two V8 engines, and with five-speed direct 7.59 to 1 (in first) transmission, has a drawbar pull of 24,822 lb.

Theoretical gradability of the Model E with an 8,000-lb load is 38%. For the FT, with the same load, theoretical gradability is 177%. The Model E weighs approximately 9,900 lb and has a track area of 8,400 sq in., giving a ground pressure of about 1.18 psi. The FT, on the same track area, weighs 12,400 lb, giving a ground pressure of 1.48 psi. Speed of the model E at 3,000 rpm is 3.25 mph in first gear, and 20.8 mph in high gear. Speed of the Model FT has been cut down to 2.74 mph in first gear, and 17.5 mph in high gear.

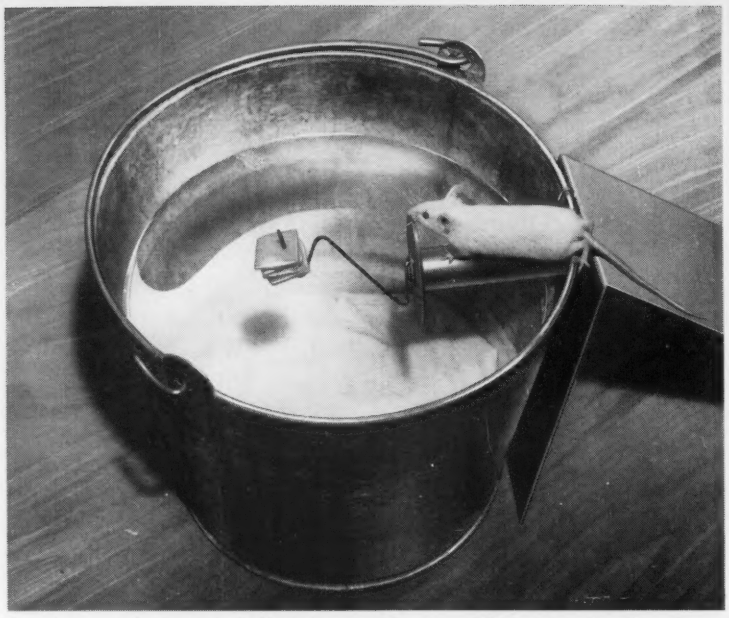
The North King consists of a tractor with enclosed cab, and a trailer section which may be used for carrying water or fuel, a drilling rig, passengers, instruments for geophysical work, or a carryall. The trailer may be varied in length or width to suit special equipment or body installations.

The cab is made of 14 gauge steel, with welded seams making it waterproof. In view of the rough country that the vehicle is designed to operate in, the makers have tried to make the North King as rugged as possible, and to allow for the added weight in extra track area.

Anti-friction bearings are used throughout the power train, and the unit is equipped with 13 x 24 six-ply tires, four-wheel hydraulic truck brakes and a mechanical parking brake. Standard equipment includes a heavy-duty front-mount winch, driven by a side-mount power take-off with one speed forward and one reverse.

The company has followed a policy of simplicity of design and easy accessibility of component parts for easy maintenance in the field. The parts are standardized and, with the exception of power train components, hydraulic equipment, bearings and tires, are made at the North King plant.

Although the vehicle was designed originally for use under off-highway conditions in Canada's north country, officials of the firm say they have recently received inquiries about the vehicle from various other parts of the world with rough-country transportation problems. One inquiry, from the Belgian Congo, expressed interest in the possibilities of its use in sand. The U. S. Army is also interested and it has already been tested by the Canadian army in exercises in the northwest territories. ★



Napoleon wisely kept both hind feet on the rim while posing for the picture.

Now Science Comes to the War on Mice

FOR THIRTY YEARS, George Sees of Owen Sound (Ont.) has been trying to build a better mouse trap. Now, at 64 he says he has found the answer: a rotatable tube like runway with wide flange at one end, on a support hung over the edge of a pail of water.

Inventor Sees, who refers to his trap as a "mechanical cat" because it never needs to be re-set, claims that it will outdo the best cat living in mouse-catching ability.

The mouse is lured from a board or ramp leaned against the pail by the traditional piece of cheese, which is spiked on a wire bait-holder beyond the flange at the far end of the cylinder. At first the runway is reassuringly stable under the mouse's weight; but as he tries to pass over the flange to reach the bait the runway tube spins on an inner bearing cylinder and drops him into the water below.

DESIGN ENGINEERING borrowed a tame mouse (name: Napoleon) and persuaded him to pose on the trap to show readers the principle in action* (see picture).

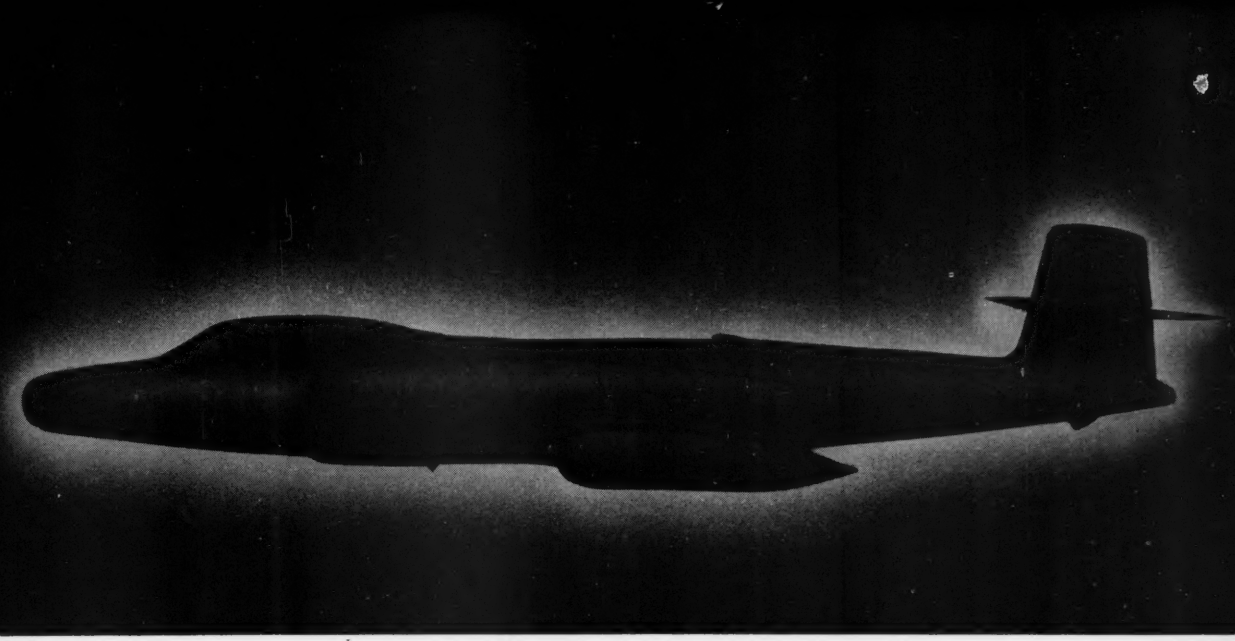
The idea first came to George Sees soon after the first world war when he was troubled by a growing mouse population in his home. He began with a cardboard cylinder fitted over a broomstick, then allowed 30 years to pass before perfecting the idea.

He has another model which is slightly more complex; in this one, the rotatable runway tube rests on the inner cylinder at the rear end but, its far end (which is closed except for a small bearing hole) is supported on a thin wire pivot set into the end of the bearing cylinder. So, the friction between the runway and its support at the near end, gradually decreases to almost zero where it rests on the wire—and the runway becomes fatally unstable. At a point close to the bait the mouse capsizes suddenly, drops into the water (as in the simpler version) and drowns.

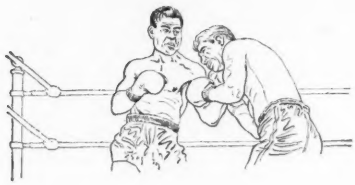
The inventor patented his design and showed it for the first time to the buying public at Owen Sound's industrial fair last year.

Few people were interested. But very recently it has gone into use by Owen Sound beekeepers who happily report record catches so proving that the working principle is sound. ★

*Napoleon was not allowed to fall off the cylinder and came to no harm. Water in the bucket was supplied by DESIGN ENGINEERING'S art department



How a fighter loses weight and gains strength...



A boxer "sweats off" excess poundage when he wants to make the weight. Often this results in loss of strength and sometimes the fight. On the other hand a fighter aircraft can lose weight by using Canada Decal Transfers and not lessen its fighting power one iota.

Aircraft have lost as much as 18 pounds with the use of tough Canada Decalcomania Transfers in place of metal plates for pilot instructions, instrument dial markings, fuselage and engine markings.

The ability to adhere to almost any surface and stand up to extremes of weather and temperature makes the uses for Canada Decals in industry as unlimited as your imagination.

Canada Decals are made for easy precision positioning and once on, are there for good. Specify Canada Decals.

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CD2-5

Sturdy Dart

(Continued from page 22)

swirl vanes. Initial ignition is by means of igniters in chambers 3 and 7.

Tubes interconnect each chamber with its neighbor and it is through these that the flame is spread during starting. To allow expansion and yet have a gas-tight joint, the chambers at the rear end are supported in the nozzle housing on the piston-ring seals. The front attachment to the compressor outlets is a two bolt fixing on to a spherical seal.

On the port side there is a series of pipes to allow any surplus fuel to drain away during engine starting and stopping.

The exhaust unit consists of outer casing carrying an inner cone on three struts. The struts, of aerofoil shape, help to reduce turbulence in the gas stream at the turbine exit. The unit can be supplied either straight, or inclined, to suit particular installations. A jet pipe, behind the exhaust unit, carries the gas stream to atmosphere. ★

Steel Castings

(Continued from page 42)

other surfaces have the cast skin removed by fettling or grinding, followed by shot blasting. These are specification requirements. They are based on the improvement in fatigue properties of a cast surface from which all scale, surface imperfections and small particles of molding sand have been removed, as well as the presence of compression stresses on the surface due to the peening action of the shot-blasting operation. This casting is some 7½ in. diameter and of about the same height; it weighs 18½ lb as delivered.

It must not be assumed from these remarks that high-tensile alloy steel castings have found ready acceptance in aircraft construction. The truth is they have not! Mostly this is because they are costly as a result of the careful quality control and inspection needed to make them safe.

Aircraft quality steel castings can compete with forgings only when the part is complex and consequently difficult and expensive to forge.

It should not be forgotten, however, by manufacturers outside the aircraft industry, that the technical know-how which is capable of producing an aircraft quality steel casting, can also produce this same quality in a high tensile commercial casting.

If the acceptable quality level of inspection were reduced to suit commercial standards, the cost of the casting would be less. When die costs are compared with the cost of a wooden pattern, the economics of a small run of quality steel castings and the ability to change the pattern, at will, become readily apparent. Steel foundrymen may claim that they can produce commercial castings to the required aircraft standard without having to take the extra care which is said to be necessary. The aircraft industry would be very happy indeed if this were true, because aircraft are a very costly means of transportation and anything which would lower costs would be popular. Until such time as the present method of producing steel castings can be shown to be too severe and the inspection standard too high, we shall have to go along with it. But aircraft steel castings are no longer the novelty they were even five years ago; many are now in use. ★

Television

(Continued from page 23)

of over-the-horizon transmission, 10-kilowatt transmitters and 60-foot-diameter antennas are being used. This is 20,000 times the power and 30 times the antenna area used in the present transcontinental microwave system. It was found necessary to use the lower frequencies (in the UHF band) so that sufficient power and reliability could be developed with available gear.

Even after scientists learned that this form of transmission was possible, they were not certain that the medium would support the broad band of frequencies needed for multi-channel telephone or television work. But then in the fall of 1953, they were able to transmit 12 voice channels over-the-horizon.

Television was first successfully transmitted in this way in 1954 between Holmdel and the Round Hill Research Station near New Bedford, Mass.—distance of 188 miles.

Bell and MIT scientists emphasize that the new method of transmission will probably supplement rather than replace line-of-sight radio relay systems. ★

It is Risky to Copy

Standardization of parts for the jigs and fixtures used in machine tool work was pioneered in England by Purefoy United Tooling Limited. Its coded catalogues, conveniently listing parts and sizes, were unique in this field for several years.

But when former Purefoy employees Sykes and Boxall set up their own unit tooling business and sent out almost identical catalogues, it was easy to see they were trying to take advantage of Purefoy's hard-won reputation and of the careful thought and labor that went into the catalogues.

To win evidence of this, Purefoy sent some "trap" orders to Sykes Boxall & Company Limited — orders that were obviously intended for Purefoy. When Sykes Boxall filled them without explanation just as if they were actually selling Purefoy parts, Purefoy sued.

Although Sykes Boxall argued that they had sent along their own catalogues when they filled the orders (to prevent misunderstanding) the court ruled that they had "passed off" their own parts as Purefoy's.

When the question of copying the catalogues came up in court, Sykes Boxall argued that like anyone else, they were free to sell the same parts as Purefoy did, and had to list the same range of sizes as Purefoy's. But the court ruled that Purefoy could prevent anyone from copying its tables of parts. And although Sykes Boxall were able to show that some of their tables had been made up without copying, they admitted that others had been. But not from the Purefoy catalogue! They had been copied from a catalogue of one of Purefoy's customers, de Havilland Propellers, Limited. The court ruled that because de Havilland had made its catalogue (with permission) from the Purefoy catalogue, Sykes Boxall had indirectly infringed Purefoy's copyright — and had to pay damages.

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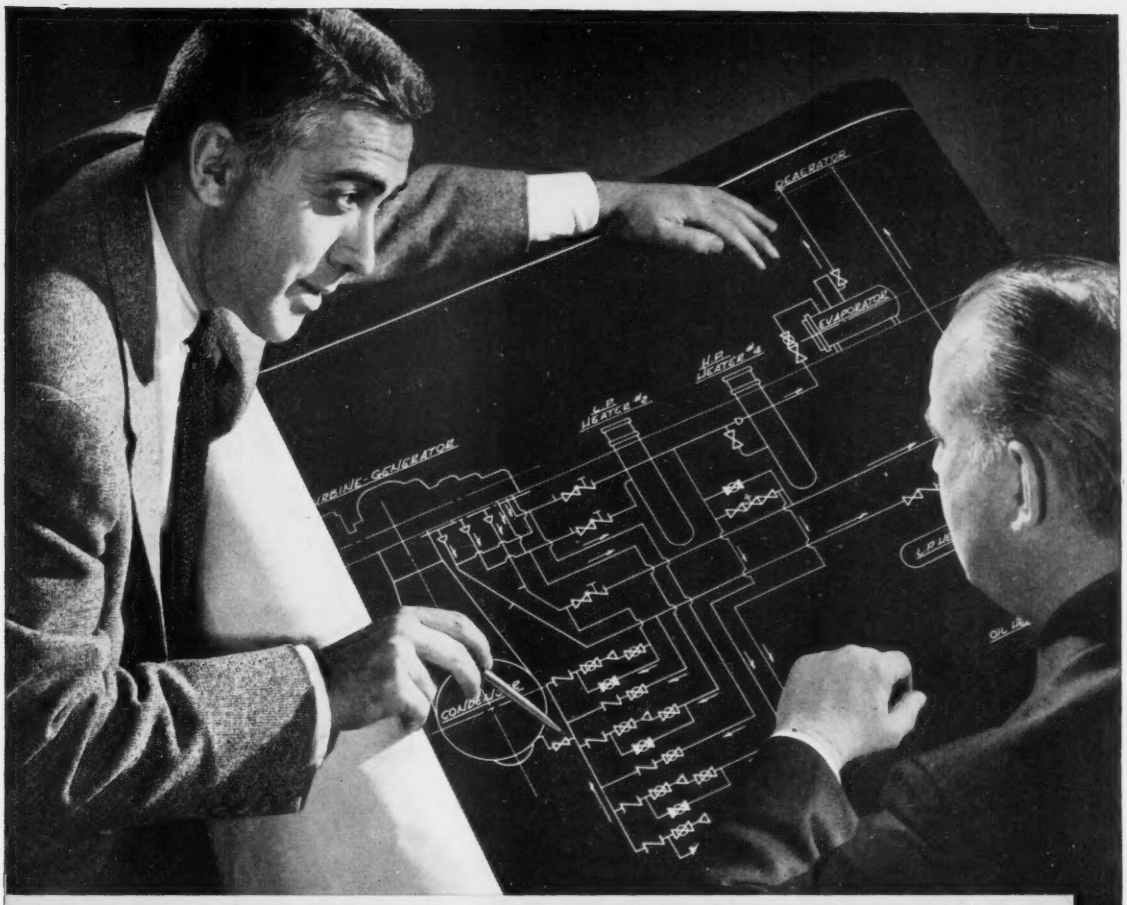

X-thousand chances to be wrong...or right!

IT'S HERE when piping is in the blueprint stage that both original costs and operating costs are determined. Make the wrong choice—an inferior valve—for just one location and it may mean only *a little extra* maintenance later on. But if "wrong" valves are specified at a dozen, a score —or more—locations, the *added* cost for excessive maintenance can become hard to take . . . especially when many a valve failure can disrupt an entire plant operation.

You can avoid trouble and wastefully high maintenance by discerning purchase of valves and fittings of greater suitability, greater dependability. Quality becomes the important specification. That's why it's thrifty buying to depend on the consistent quality of the broad Crane line.

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Quotes

Points from current papers and speeches

A PAPER read by **J. Manhajm** and **D. C. Sweeney** before the Hydraulics Group of the Institution of Mechanical Engineers was an investigation of **hydraulic lock.**

This is met with in piston-type control valves governing the supply of high pressure oil to mechanical equipment. It is liable to occur when conditions are such as to produce an axial pressure gradient in the fluid contained in the clearance space surrounding the piston lands and its effect is to cause sticking or locking of the piston in its enclosing cylinder.

A preliminary investigation carried out in the mechanical engineering department of Birmingham University indicated that true hydraulic lock is essentially a hydro-dynamic effect, resulting from asymmetric pressure distribution in the clearance space between piston and cylinder. Thus if, owing to machining imperfections in the piston lands or cylinder bore, the flow of fluid in the clearance space is either diverging or converging, an asymmetric distribution of pressure will in general result and will be accompanied by a transverse thrust on the piston. If the clearance is divergent in the direction of flow, the piston will be forced against the cylinder wall; if convergent, the action of any thrust arising will be to exert a centralizing effect.

The paper dealt with an extension of the investigation referred to above, the object being to examine, both theoretically and experimentally, the effect on hydraulic lock of using tapered piston lands. For this purpose, a mathematical analysis was made of the pressure distribution in the clearance space between piston lands and cylinder bore and of the accompanying side forces on the piston for a range of selected conditions. To establish the validity of the analysis, experiments were carried out on a cylinder of uniform bore in conjunction with dumb-bell-shaped pistons having lands giving various taper-clearance ratios. In general, the procedure was as follows: high-pressure oil was supplied through the cylinder wall to the annular space between the two lands of the piston, the oil then flowing outward in both directions through the clearance space. Pressure tappings at a number of points in the cylinder wall allowed the pressure distribution in the clearance space to be determined, and suitable provision was made for the measurement of any locking force acting on the piston.

AN EXPERIMENT was tried in a recent **Stanford Research Institute** News Bulletin: Research for Industry, by printing it in **Interlingua,** a proposed international, scientific language.

Anyone who can read technical matter written in one of the major European languages can, it is claimed, follow Interlingua because it uses common word material and operates with a minimum of grammatical factors.

To test this for yourself, here is an extract from the article in question:

Un simple furno solar es in production commercial pro uso in India (que es povre in combustibiles sed ric in sol). In Algeria un furno con un speculo de plus que 8 m. esseva construite pro producer fertilisante per fixar nitrogeno atmospheric.

The free translation: A simple, solar stove is being manufactured for sale in fuel-poor, sun-rich India. In Algeria a furnace with a 27 ft. mirror was built to produce fertilizer by fixation of nitrogen in the atmosphere.

• • •

IN AN ASTE PAPER, Tooling for Cold-Steel Extrusion, the speaker, **J. F. Leland,** explained that in engineering literature over the last year or so little space has been given to extrusion tool and die design.

This in spite of the fact that tool design can be the difference between success or failure in the production manufacture of any item by cold extrusion.

Simply stated, extrusion involves pushing around a given quantity of metal until it assumes a usable shape and surface finish. This is in contrast to the usual manufacturing process of taking a larger piece of metal and discarding the portion machined off.

Assuming that a given product is suitable for cold extrusion, basic tool design principles can be laid down and should be adhered to in obtaining a given shape. Other factors, such as lubrication, the number and variety of cold work operations, the raw materials and their heat treatment must be closely analyzed and controlled but cannot make up for wrong tool design and construction.

Extrusion operations can be divided into two main classes: (1) backward extrusion and (2) forward extrusion. A third class, a combination of (1) and (2), is performed in one operation.

In a backward extrusion, as the descending punch enters the slug contained in a closed die, the displaced metal is compelled to flow up around the punch, in the opposite direction to the punch travel. The wall thickness of the cupped shape so produced is equal to the clearance between the punch bearing and the die.

In a forward extrusion, the descending punch forces the confined metal to flow through the die in the same direction as the punch travels. The diameter of the extruded section is determined by the diameter of the die bearing. If a tubular section is being formed, the wall is determined by the clearance between the punch extension and the die bearing.

• • •

ORIGINALLY DEVELOPED to protect steel parts **against oxidation and corrosion,** especially at high temperatures, General Motors' Aldip aluminum coating technique can be used to double automotive engine valve life, according to company researchers.

Addressing the midwinter meeting of the Society of Automotive Engineers in Detroit, Mich., **Dr. R. F. Thomson** and **D. K. Hanink** of GM Research Laboratories Division, **E. B. Etchells** of the Chevrolet Division and **K. B. Valentine** of the Pontiac Division explained how the Aldip process has been applied successfully to automotive engine intake and exhaust valves. Previously, it has been used with great success on exhaust manifolds, heat exchangers and turbine engine components.

Use of Aldip on engine poppet valves, however, is the first application of the process to moving parts of an engine. The researchers described two general methods for applying an aluminum coating to a steel part.

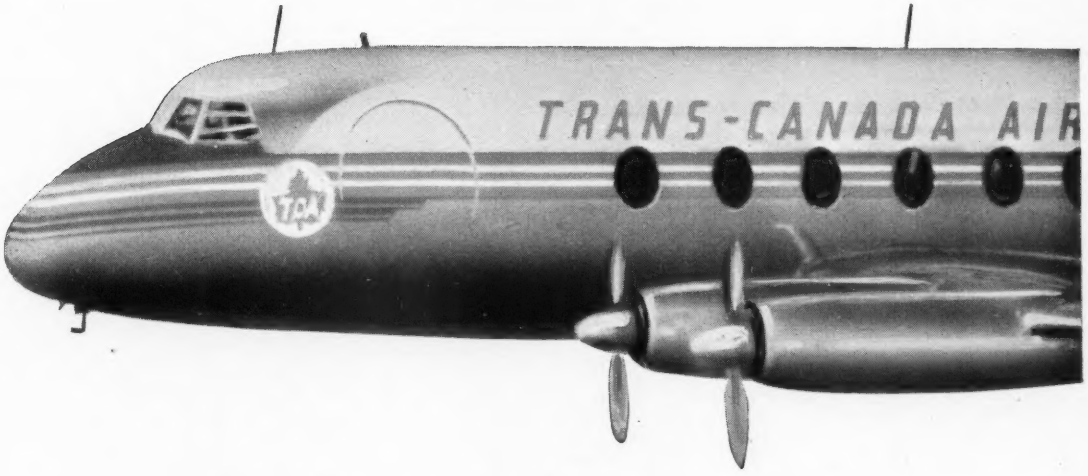
The original method, especially adapted to coating intricately shaped parts, is to preheat the part in a special patented salt flux and then dip it in molten aluminum. Excess aluminum clinging to the part after the dip is blown, spun or shaken off.

A newer method eliminates the dipping operation. Aluminum is sprayed onto the steel part. Then the part is heated in the flux bath until the aluminum melts. This spray technique, the speakers said, makes possible quick, even application of aluminum and is particularly well suited to coating engine valves. In road tests, they added, Aldip valves lasted more than twice as long as uncoated valves of the same steel composition.

By increasing a valve's resistance to high temperature corrosion and oxidation, the Aldip process creates a better valve without increasing use of expensive, critical alloy metals. The secret of the process' protective ability, the researchers said, is the alloy layer formed just beneath the surface.

TRANS-CANADA AIR LINES

Have recently brought into service the Vickers Viscount, the world's first propeller-turbine airliner.



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Try Alkyd Color Finishes on Aluminum

By M. M. GUTWILLIG

The modern way to finish aluminum is to color it. Success can now be sure

IN THIS AGE of the heliotrope shirt for the male and the tri-toned automobile, the design engineer is anxiously following the swift developments in the field of product finishes. For it has become increasingly plain that color sells goods.

The automotive industry's pioneering and leadership in the promotion of exciting new finishes has generated a widespread interest in the outdoor use of color. A mere decade ago, it seemed inconceivable that finishes in many of the present-day pastel hues on cars could withstand rugged weathering conditions. The man who bought a maroon car resigned himself to the fact that the finish would quickly fade. But today, he can select an automobile finished in three or more harmonizing delicate tones offering good color and gloss retention for years.

Color in the home

This influence has affected consumer thinking in many related directions. Only in the early stages, for instance, is color's contribution to the exterior of homes. An impressive start has been made by the manufacturers of aluminum awnings. Fabricated aluminum strips are finished in two and three color combinations, providing the owner with a gay awning to brighten his house. Here is a trend that the imaginative design engineer can now profitably pursue.

Probably the most prolific contribution to the gloss retention and all-around durability of exterior finishes has been made by the alkyd resin based enamels. Given the proper alkyd medium or binder, combinations of pigments previously regarded as impractical were almost overnight catapulted into outdoors prominence. Even on bright colors and pastels, a satisfactory life could now be predicted with greater resistance to checking and corrosion. Combined with other synthetic resins, modified alkyd finishes could now withstand even extremes of weathering and satisfactorily resist harsh moisture and chemical conditions.

Adaptability of the alkyd-type finish to aluminum has been helped through parallel advances in application techniques. Aluminum oxidizes rapidly and special preparation is needed before the light metal is ready for alkyd primers and enamels. The process of anodizing and alodizing are used for this. The aluminum sheet is degreased and cleaned and, before it has an opportunity to oxidize, it is suitably etched—given a "tooth" to provide a medium for the desired bond.

With the early fascination of aluminum's prodigious physical properties, its outdoors appearance shortcomings were often overlooked. But now, because of its tendency to "gray off"—to lose its original lustre—it is often being given the benefit of finishing.

Contributing to better adhesion of paints on aluminum are the new vinyl resin based wash primers. Empirical data so far compiled shows that the vinyl wash primers look right for aircraft and even on steel railway tank cars and railway bridges. They will also find ready acceptance for priming aluminum doors and windows and wherever a strong bond is sought under hard weather conditions.

Most powerful argument in favor of alkyd finishes is their wonderful versatility. They have amazing flexibility, can withstand repeated physical abuse, submit to deep drawing and other fabrication hazards. For the product manufacturer, their use brings no new problem: They can be applied by dipping, spraying, by roller-coating, flow-coating and other methods.

Flow-coating, a very recent method, is as useful for finishing delicate jewelry parts as for giant fabricated metal forms. An electrical equipment manufacturer in Toronto uses a mobile version of the new technique to finish transformer housings. His flow-coater is a 12-inch pipe with a jet at the end of the hose activated by a modest 5 to 10 lbs pressure. As the operator sprays the hard-to-reach sections of the transformer housings, he stands on a grated floor. Excess paint drops through the grating, is caught and reclaimed. Transformers are exported to the far corners of the earth and satisfactorily resist a variety of widely divergent weather conditions.

If we look at the exterior of the average home, a number of uses for these new durable finishes suggest themselves. Colored garbage cans, for instance, should be a welcome relief from the monotony of the present commonplace versions—and useful protection inside and out. For exterior oil intake pipes where splashing of oil soon breaks down the finish, a tough alkyd finish would stay unspoiled. Alkyds modified with phenolic resins have resistance to extreme moisture conditions as well as to problem chemical situations. On kitchen ventilators where warm, humid air is exhausted into a cold atmosphere and the impact of condensation is harmful, a tough type of finish is necessary.

It is not from chance

Formulations of hard-wearing industrial finishes are hardly achieved through chance. Research on exterior finishes alone at the CIL paint and varnish research and development laboratories reaches astonishing proportions.

It is common knowledge that accelerated weathering tests are used to predict the life expectancy of an outdoor finish. But the company recognizes that these experiments do not exactly duplicate the actual effects of weather. For this reason, finishes intended for outdoor use are submitted to outdoor exposure under actual field conditions for prolonged periods.

Even in the fairly limited field of domestic exteriors with emphasis on aluminum finishing discussed in this brief article, the designer must ask himself: "Why am I painting? Am I merely seeking protection or do I want maximum eye appeal?" If you want appeal in your product, here is heartening news. Month in, month out, paint research is resulting in improved finishes—finishes that look better for a longer time, are easier to apply, save time on the production line through reduced drying time and are less costly. ★

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Here is a low density product with a multiplicity of applications. It is easily prepared by mixing a catalyst at ordinary room temperatures. The slightly viscous mixture can be poured or sprayed into cavities of almost any size and shape desired. During foaming, the resin expands to fill the shape of the container and after curing will bond strongly to its sides.

APPLICATIONS

ISOFOAM is recommended for use in a wide variety of applications. Batch mixing as well as continuous mixing and spraying devices open new methods of production techniques resulting in considerable savings in labour costs.

Because of its poor heat transfer, ISOFOAM is recommended for insulating home freezers, refrigerators, water coolers refrigerated trucks and railroad cars and other refrigerated units. Good for covering low temperature lines, low pressure steam lines and valve clusters located in relatively inaccessible places.

The high strength with low density, thermal insulation and acoustical properties can be used to great advantage in sandwich construction for pre-fab building panels of all types.

Engineers find the strength of ISOFOAM with only a slight increase in weight can advantageously be used in reinforcing structural units and members in the aircraft and automotive fields.

Can be used as a core material for randomes in aircraft and guided missiles.

Can be used in most types of buoyancy and flotation gear. With articles subject to constant immersion in water, an additional thin coat of paint or cover of plastic would provide extra protection.

ADVANTAGES

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  Easily mixed, convenient to apply. Mixed prior to use at point of application, and readily poured where required. Labour costs are drastically reduced.
- **Foamed in Place**
  Spontaneously expands after pouring or spraying to fill a cavity or cover a surface.
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  No external heat is necessary to cure expanded material.
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  Shows good adhesion to surfaces such as metals, glass, Fiberglas laminates, wood, fabrics and most plastics.
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File

New booklets and books written for you

ORIGINAL EQUIPMENT application ideas for product designers are given in the **Gast Manufacturing Corporation** bulletin 1054.

It shows how 35 product problems were solved by using their rotary air motors, air compressors and vacuum pumps.

These include a high vacuum disc valve using an air motor, a copying camera fitted with a vacuum pump and a steam generator operating on light and industrial fuel oils, atomized by air from a rotary compressor. (206)

• • •

A BROCHURE on power transistors by the **Minneapolis - Honeywell Regulator Co.,** shows some typical applications for this device. These include its use for driving a servo motor, for operating a speaker, for handling electrical switching operations and for operating a fuel gauge. (207)

• • •

A RANGE of linear and rotary actuators for use in aircraft are described in a brochure on electrical actuation by **The Plessey Co. Limited.**

The advantages claimed are: saving in weight, operation at extremes of temperature, simplicity of installation and ease of servicing.

An actuator is basically a remotely controlled electrical device for providing mechanical movement in positions which are normally inaccessible. A linear actuator is fundamentally a jack, acting like a pneumatic or hydraulic jack. In other words, the plunger extends or retracts as desired.

The actuator is anchored at one end, that is, at the end remote from the plunger and the plunger is suitably connected to the component requiring actuation.

In the case of rotary actuators, the plunger is replaced by a shaft which rotates in either a clockwise or anti-clockwise direction through the desired angle of travel.

Typical uses are for: oil cooler shutters, ventilator flaps, fuel cocks, by-pass valves, parking brakes and landing lamps. (208)

• • •

IN BULLETIN C-DT-1 are given details of the **Brown Boveri (Canada) Ltd.** distribution transformer BB-99.

This transformer was designed to provide maximum performance with high efficiency, better regulation and lower losses

The coils are wound from continuous strip, cold rolled steel making possible controlled uni-directional grain orientation and thus uniformly high magnetic permeability. The cores which are not cut or distributed in any way during coil assembly, require exceptionally low exciting currents.

The coils are wound directly round the core legs by a patented method, which gives them both a superior electrical efficiency and a very high mechanical strength against short circuit stresses. Improved cooling with uniform dissipation of heat from all parts of the active assembly guarantees longer insulation life and higher operating performance under all conditions.

The BB-99 distribution transformer is designed to meet all relevant CSA specications. (209)

• • •

THE NO-OX-ID CATALOGUE of the **Dearborn Chemical Co.,** was prepared to assist in solving corrosion problems.

Details are given of oil type rust preventives, used where lubricating qualities are desired, as in internal combustion engines; grease or wax type when exposure conditions are severe, as for instance, in the interior of a water tank; solvent cut-backs used in the protection of precision parts during assembly and inspection; drying resin type used outdoors for weathering conditions and indoors on control panels where heat resistance is desired. (210)

• • •

INDUCTION HEATING equipment for the metalworking industries is the subject of a **Westinghouse** brochure.

The rapid heating under cleaner, cooler working conditions made possible with induction heating permits many heating operations to be carried out right on the production line.

Its advantages for forging, hardening, heat treating and joining are set down in the brochure and details of motor generator sets are given.

Details are also given of motor generator work stations and radio frequency generators, as well as their accessories. (211)

• • •

DETAILS OF THE Davohm Series 850 resistor are given in a leaflet of the **Daven Co.**

This new resistor has been developed to fill the long existing gap between wire-wound and composition types. It is small and has definite and predictable accuracy.

The resistive element is deposited on the inner surface of a glass tube. The resistor is an alloy of pure, noble metals to which connections are made by silver bands fused to both it and the glass. The caps are bonded with a true glass to metal seal, providing complete hermetic sealing and protection for over 60 psi pressure. Since the element is inside the tube there are no protective coatings to break down.

In this resistor the film actually has the same characteristics, such as resistivity and temperature as that of the bulk base metal.

The resistor can be seen under a microscope as a smooth, shiny metal with no broken, ragged edges such as are formed in films by the usual spiraling techniques which mechanically cut through the film. This cause of noise, erratic readings, hot spots and opens is completely eliminated.

The noise voltage of these resistors is very low since they act like solid metal elements. On one set of Series 850 resistors the noise was below 0.040 microvolts per volt which is no more than that measured on good precision wire-wound resistors. (212)

Book Department

Materials of Construction

MATERIALS OF CONSTRUCTION. Their manufacture and properties (Wiley) by the late **Adelbert P. Mills,** has been rewritten and edited by **Lloyd F. Rader.**

The claim that this book is designed for use by engineers and students in all branches of engineering is well founded. Its 650 pages give a splendid over-all picture of the materials field.

The book divides itself into three main divisions. The first 300 pages, and the last 100 or so, will be the chief concern of the design engineer, since they cover subjects which are of prime importance to him. Particularly is this the case in chapters 2 and 3, Tests and Service Requirements, including tensile, fatigue, creep, magnetic particle, X-ray, gamma-ray and supersonic inspection; and chapters 5 to 12 on wrought iron, malleable cast iron, steel and non-ferrous metals and alloys.

The part of the book between pages 301 and 543, whilst interesting and necessary for the over-all picture to be complete, is more directly useful to the civil engineer or builder.

Pages 544 onward are important. They discuss organic plastics, laminates and adhesives and organic protective coatings.

The book is very well worth having at $7.50 (Canadian price). ★

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Eureka

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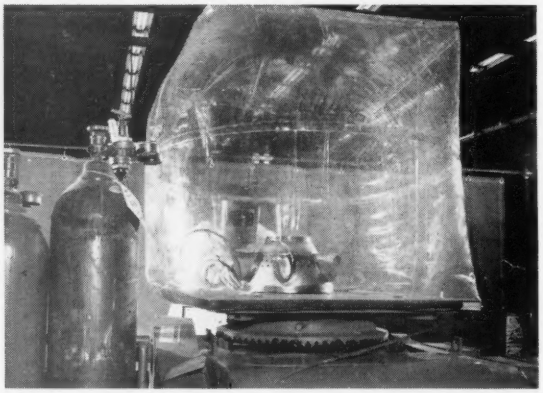
WOODSTOCK ONTARIO CANADA

Design news in pictures

Some modern designs making news today

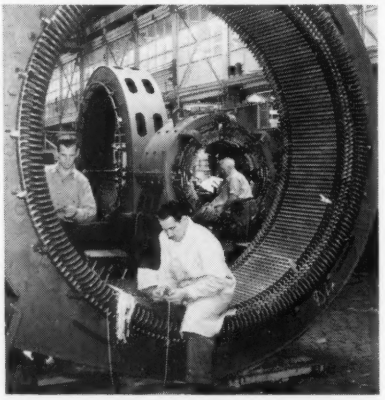
Testing Orenda's jet engine. This is the control room where engineers watch and listen to new power units proving themselves before going into long-time service.



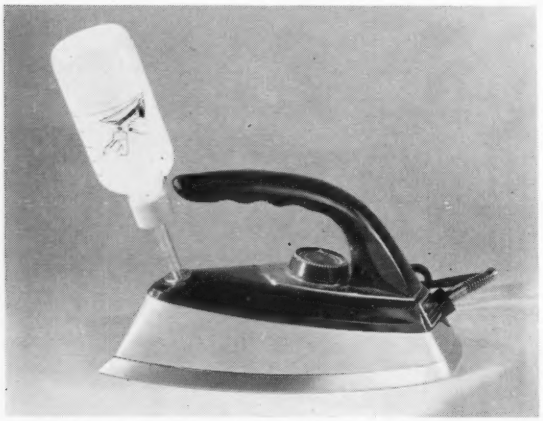
Titanium welding must be done in inert gas. Here is the Solar gas-tight plastic tent which makes it possible. The welders gloves are part of the bag, but give him freedom.

New medical X-ray unit turns the patient upways. It is more revealing.

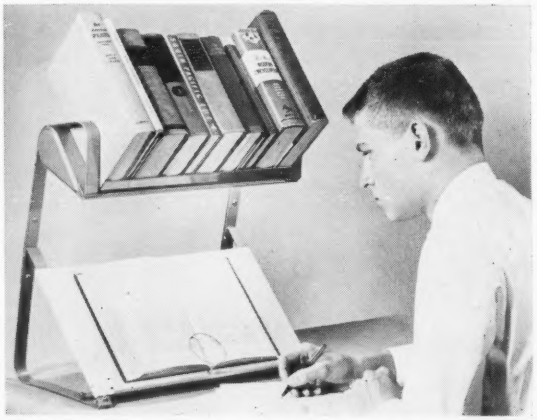
U. K. is testing a modern wind mill which makes electricity.



Westinghouse pulp-grinder motors tower over men lacing them with Thermalastic.



An all Canadian prize winning steam and dry iron. It has won approval from NIDC and from the buying public. It features a new and exclusive water filling idea.



Twelve months research went into this combination book-rack and lamp. Also built-in are a book rest and page holder. A U. S. design by New Yorker W. J. Flannelley.

G-E CARBOLOY THERMISTORS...
offer detection, measurement and control of energy to a degree Never Before Practical...

G-E CARBOLOY THERMISTORS are circuit elements with a highly sensitive response to minute changes in temperature. They have a negative coefficient of resistance — *resistance decreases with increased temperature* — and, their temperature coefficient is much larger than that of any other known material. These features, coupled with excellent stability and aging resistance, offer industry and science the opportunity to detect, measure and control energy to a degree never before economically possible.

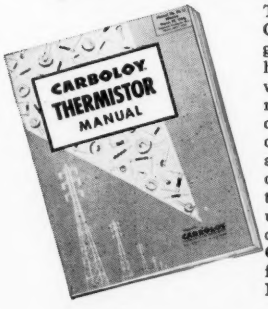
Carboloy Thermistor applications can be divided into two broad classifications, depending upon the operating characteristics of the element used and the functions performed. These are determined by whether: (1) the element is controlled by ambient temperature; or (2) the element is heated by the current in the circuit with which it is associated. The first includes applications involving temperature measurement and control, and temperature compensation. The second, covers uses involving voltage-current and current-time characteristics; such as time delay devices for relay operations, timing devices, sequence switching, safety and warning circuits, voltage regulators, flow meters and vacuum gauges.

✓ CHECK THESE FEATURES

1. **A large negative temperature coefficient of resistance.**
2. **Response to minute temperature changes.**
3. **Permits local or remote temperature measurement.**
4. **Offers temperature control never before practical.**
5. **Can eliminate mechanical timers.**
6. **Can eliminate current surge in electrical circuits.**
7. **May be used with electrical conductors to compensate for changes in their resistance due to temperature changes.**
8. **Will reduce cost, size and weight of products and processes.**
9. **They last indefinitely — need no maintenance.**

CARBOLOY THERMISTORS

Free Technical Manual Gives Application Data and "Ideas"



This free technical book, Carboloy Thermistor Manual, gives extensive information helpful to persons concerned with the design or improvement of products and processes. It includes basic circuits and performance curves, and "idea" circuits, with curves, are provided as a guide to the best utilization of the unusual operating and physical characteristics of G-E Carboloy Thermistors. Write for this 56-page manual today. Mail the coupon below.

Carboloy and Metals Section
Canadian General Electric Co. Ltd.,
1025 Lansdowne Ave.,
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CANADIAN GENERAL ELECTRIC COMPANY LIMITED

Patents

Some new ideas win protection in Canada

A PROCESS for giving zinc a lustrous protective finish is covered by Canadian Patent 511,105, issued on March 15 to Poor & Company, Chicago, Illinois.

According to the patent, the zinc surface is stained yellow-brown with a chromic acid solution and treated with a hot solution of sodium silicate to produce the corrosion-resistant finish.

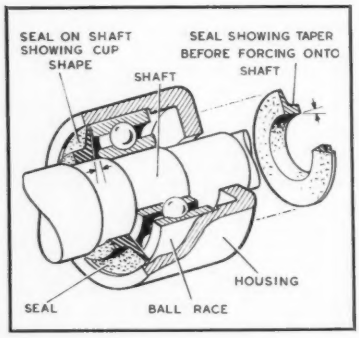
• • •

AUTOMATIC WINDING for clocks in automobiles is the subject of Canadian Patent 513,368, issued on May 31 to Indianapolis inventor Morris Goodman.

The main spring of the clock is linked by a rack and spindle to a plunger that is moved each time the car door is closed. The clock is mounted in the usual position on the dash.

• • •

WESTINGHOUSE ELECTRIC Corporation of Pennsylvania has obtained Canadian



Patent 512,597 on this bearing seal arrangement.

The disc-like rubber or plastic seals fit on the shaft at each side of the bearing. The bore of each seal is tapered as shown, so that the seal is drawn into a cup-shape when it is forced onto the shaft.

The patent, which was issued on May 3, names Ephraim H. Anderson of Buffalo as the inventor.

• • •

A NEW METHOD for making laminated direct current electromagnet cores by compressing and sintering powdered metals is claimed in Canadian Patent No. 512,047 issued on April 19, 1955 to General Aniline & Film Corporation. Sintered metal layers are alternated with thin layers of refractory insulating material. The metal layers are spot-interfused through the insulating material.

The cores are produced by mixing iron powder in a mold with particles of a metal like tin that will melt at the sintering temperature for the iron. The layer of powdered metals is compacted under pressure and then covered with a thin insulating layer of a refractory oxide such as magnesium oxide. A further charge of magnetic material is then introduced and compressed. The process is repeated until a body of the desired size is produced. The laminated body is again compacted, and removed from the mold and placed in a sintering furnace.

The invention, by Waldimir J. Polydoroff of Chicago, is said to give high permeability and low retentivity despite the use of compacting pressures under 50 tons per square inch, and to be particularly useful where shapes that are difficult to machine from ingot iron are required.

• • •

A SILICONE coating for cooking utensils, covered by Canadian Patent 510,541, is said to mean open flame cooking without staining, frying without fat, and easy cleaning with a damp cloth.

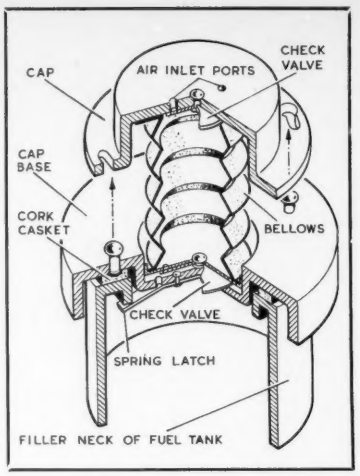
The inventors, Paul S. Webb and John R. Koster, of Boulder City, Nevada, believe that the coating seals the pores of the metal so that carbon or other contaminating or staining materials are prevented from entering the pores of the metal. Because the surface is highly water-repellent, the coating has another use—to prevent ice cubes from sticking to freezing trays.

Methyl silicone is recommended for the coating, but other silicones may be used. It may be applied by spraying, dipping, or brushing, or by depositing the silicone on a wet utensil by reaction with fumes of chlorosilicane.

The patent issued on March 1, 1955 to Processed Surfaces, Inc., of New York.

• • •

A NEW glass drill, invented by Wilbur C. Palmer of Corning, was patented in Canada on May 3 by Corning Glass Works. It has a leader drill bit that is triangular in cross-section, and a cluster of three similar drill bits arranged symmetrically around the leader bit. Each bit in the cluster has one of its flat sides lying against one of the flat sides of the pyramid-shaped leader bit. The Canadian patent number is listed as 512,485.



THIS EMERGENCY pump cap for fuel tanks, invented by Martin P. Schera, Jr. of Pelmaro, New Jersey, allows the motorist to pressurize his fuel tank if his regular fuel pump breaks down. It is now protected by Canadian Patent 513,233, issued May 31.

The cap has a base that fits the filler neck on standard tanks like an ordinary cap. This base has a valve to let air into the tank and it carries a bellows between it and a top cover. Another valve in the cover lets air into the bellows, and a few up and down strokes of the top cover give the pressurization needed to force gas to the engine. When not needed as a handle the cover locks in place and the whole assembly is used like a regular cap. Air can enter the tank through the valves to allow normal fuel flow out of the tank.

• • •

A FLAME RETARDANT coating for treating fibre composition board was patented in Canada on April 26th (No. 512,300) by Minnesota and Ontario Paper Company of Minneapolis.

Invented by Edgar A. Lauring of International Falls, Minnesota, the material contains a foam-forming ingredient, powdered sodium tetraborate, suspended in a thermo-plastic paint vehicle. Calcium carbonate and lithopone pigment, a drying oil and boric acid are the other ingredients.

• • •

A SPHERICAL building framework in which the main structural elements are interconnected to form a three-way grid of equilateral triangles is a subject of Richard B. Fuller's Canadian Patent No. 512-422 issued on May 3.

Fuller, well known designer of unusual structural forms, sets up the three-way grid by using main structural elements arranged in a pattern of arcs that are like "great circles" on a sphere. These are interconnected by sliding interlocking joints to complete the framework.

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Editorial

Industrial Design Leaves the Engineer Behind

DESIGN ENGINEERING has put some questions to industrial designers. The chance came when ACID (Association of Canadian Industrial Designers) held its June general meeting in Toronto and a group of members agreed to meet the editors.

The biggest question was a general one: "How closely related are industrial designers to creative engineers?" The answer was disturbing. In theory, claims ACID, the relationship is very close; but in practice it is one sided. Designers are anxious to work with engineers; but for the most part engineers prefer to be left alone.

The next question took this thought further. "How many engineer members do you have?" ACID's first astonishing reply was "one" — later corrected to "two!" It is true that the total membership is only 30. But the association has been chartered since 1948 and is the only body able to give professional status to product designers. It is surely remarkable that only two graduate engineers have found their way into the group.

"Why do you suppose engineers are not more interested?" came next. A spokesman for the association gave an informal answer: "Probably because engineers are fully occupied; and because they just don't bother too much with aesthetics."

The first part of that opinion is true; the briefest look at Canadian industry shows that its engineers are fully occupied with the problems of growth.

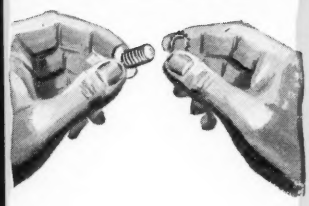
But the second part is more difficult to assess. Engineers may tend to feel that aesthetics are a small part of product design; their training may lead them away from capricious theories of fashion and beauty to the stabler ground of measurement and proof. But it does not destroy their feeling for good design, for craftsmanship and simplicity of form and logical arrangement—the qualities that take design beyond the surface, clear of fashion.

And if this is the engineer's approach, he is in good company. He has the industrial designer right beside him—for he too, is more than a free aesthete.

A very able patent attorney close to inventive engineers and designers of all kinds sees product design as a three-man job. First comes knowledge from the pure researcher, then general uses from the applied researcher. It is a third man who goes on from there to design a product for sale. Should he be an engineer? There are many reasons why he should be, but quite often he is not. Forty percent of ACID's members (Canada's official product designers) are architects.

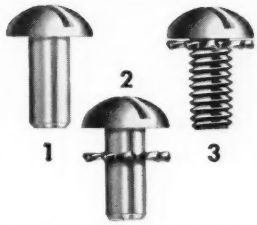
Design Engineering believes the reason for this is not disinterest from engineers at all — but the simpler fact that ACID is little known to them and industry. This magazine is in a better position than any other to put the omission right. It will do so. Future issues will carry articles specially aimed to link two groups with much between them to share.

Why SEMS-by-SHAKEPROOF reduce assembly costs!

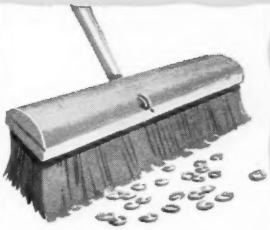


Putting lock washers on screws by hand is costly and time consuming.

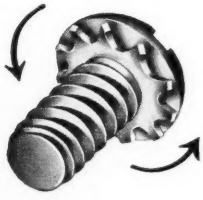
With pre-assembled SEMS-by-SHAKEPROOF two parts are handled as one.



The lock washer is mechanically pre-assembled on the screw —held on by the rolled threads.

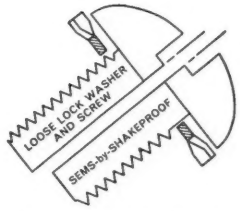


Lock washers can't drop off, can't be wasted or "forgotten."



The lock washers on SEMS-by-SHAKEPROOF always rotate freely...

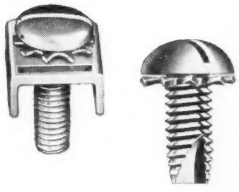
Multiple, tapered-twisted teeth give positive mechanical locking action.



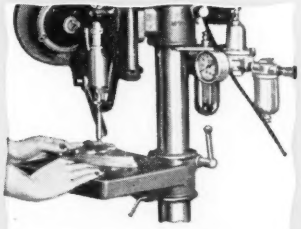
Locking teeth fit closer under the screw head for maximum locking power.

You get the best protection against vibration loosening with SEMS-by-SHAKEPROOF.

Shakeproof's complete line of standards will meet nearly every assembly need.



Specials and multiple-piece units make the range of application unlimited.



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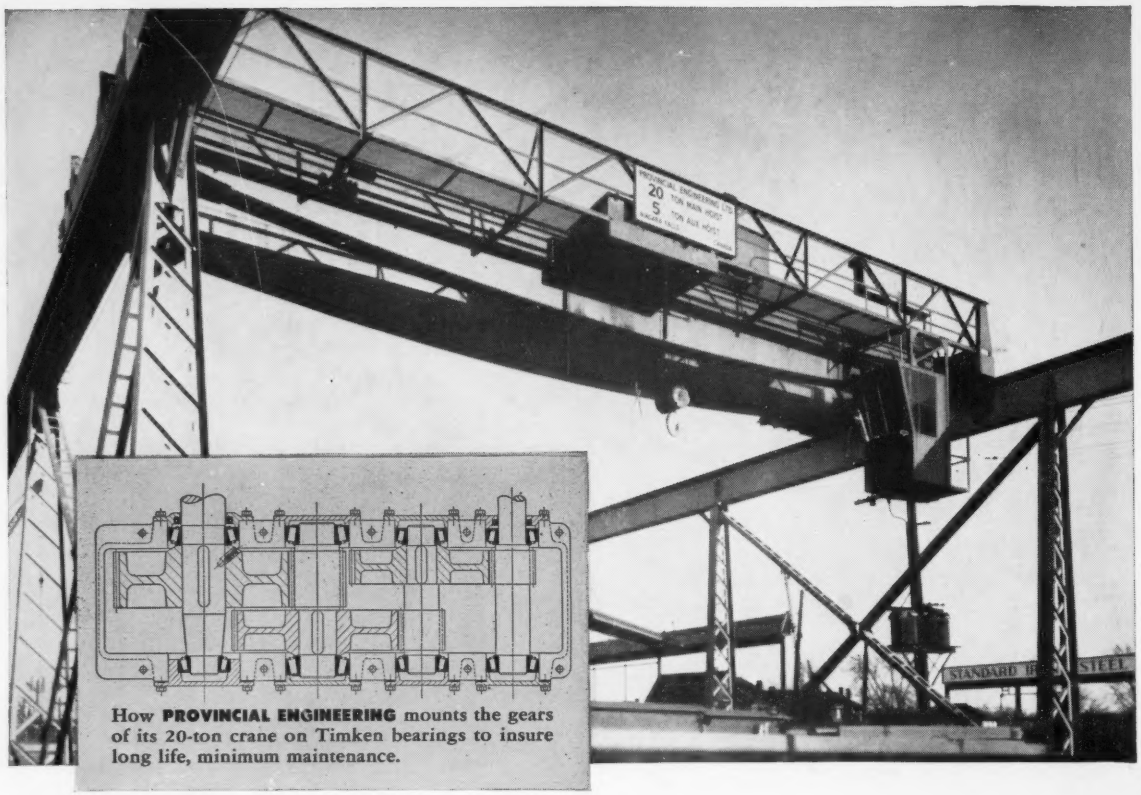

How **PROVINCIAL ENGINEERING** mounts the gears of its 20-ton crane on Timken bearings to insure long life, minimum maintenance.

TIMKEN bearings keep Provincial cranes on the go—and have for 13 years

THIS 20-ton overhead traveling crane made by Provincial Engineering Limited uses 33 Timken tapered roller bearings to keep it on the go.

Timken bearings are used in the gear boxes which employ single helical gearing. Due to their tapered design, Timken bearings take both radial loads and thrust loads in any combination. And full line contact between rollers and races gives Timken bearings extra load-carrying capacity. They hold crane shafts in rigid alignment, reduce gear wear, lengthen gear life. In addition, Timken bearings practically eliminate friction with their true rolling motion. The result—the crane operates smoothly and easily.

Also of importance, maintenance and lubrication costs are held to a minimum. Timken bearings hold housings and shafts concentric making closures more effective—dirt stays out, lubricant stays in.

Little wonder, then, that Provincial, like so many other manufacturers of fine machinery, look for the trade-mark "Timken" on every bearing they buy. Timken bearings make all machinery run better, last longer. Whether you buy or build machinery, make sure it has Timken bearings.

The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

CANADIAN PLANT: St. Thomas, Ontario.

U. S. PLANTS: Bucyrus, Canton, Columbus, Mt. Vernon, New Philadelphia, Wooster, and Zanesville, Ohio; Colorado Springs, Colorado.

TIMKEN

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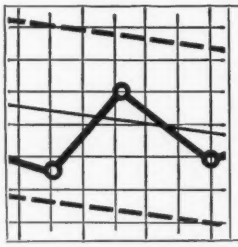
TAPERED ROLLER BEARINGS

NOT JUST A BALL ◯ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭

BEARING TAKES RADIAL ↓ AND THRUST →◯← LOADS OR ANY COMBINATION ✳



STATISTICAL QUALITY CONTROL

To insure uniform high quality and closer tolerances, the Timken Company uses statistical quality control. With it, tolerance deviations are plotted graphically. It's one of industry's newest, most scientific methods of improving product uniformity.

MADE IN CANADA FOR CANADIAN INDUSTRY